

00/80/60

<b>UTILITY PATENT APPLICATION TRANSMITTAL</b> <small>(Only for new nonprovisional applications under 37 CFR 1.53(b))</small>		Attorney Docket No. <b>2355.12108</b>
		First Named Inventor or Application Identifier <b>KIYOHIDE SATOH, ET AL.</b>
		Express Mail Label No. <b>1C5511/650463</b>

<b>APPLICATION ELEMENTS</b> <small>See MPEP chapter 600 concerning utility patent application contents.</small>		<b>ADDRESS TO:</b> Assistant Commissioner for Patents Box Patent Application Washington, DC 20231
<p>1. <input checked="" type="checkbox"/> Fee Transmittal Form <i>(Submit an original, and a duplicate for fee processing)</i></p> <p>2. <input checked="" type="checkbox"/> Specification      Total Pages <b>57</b></p> <p>3. <input checked="" type="checkbox"/> Drawing(s) (35 USC 113)      Total Sheets <b>17</b></p> <p>4. <input checked="" type="checkbox"/> Oath or Declaration      Total Pages <b>2</b></p> <p>a. <input checked="" type="checkbox"/> Newly executed (original or copy) b. <input type="checkbox"/> Unexecuted for information purposes c. <input type="checkbox"/> Copy from a prior application (37 CFR 1.63(d)) <i>(for continuation/divisional with Box 17 completed)</i> <b>[Note Box 5 below]</b></p> <p>i. <input type="checkbox"/> <b>DELETION OF INVENTOR(S)</b> Signed Statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).</p> <p>5. <input type="checkbox"/> Incorporation By Reference <i>(useable if Box 4c is checked)</i> The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4c, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.</p>		
<p>6. <input type="checkbox"/> Microfiche Computer Program <i>(Appendix)</i></p> <p>7. Nucleotide and/or Amino Acid Sequence Submission <i>(if applicable, all necessary)</i></p> <p>a. <input type="checkbox"/> Computer Readable Copy b. <input type="checkbox"/> Paper Copy <i>(identical to computer copy)</i> c. <input type="checkbox"/> Statement verifying identity of above copies</p>		
<b>ACCOMPANYING APPLICATION PARTS</b>		
<p>8. <input checked="" type="checkbox"/> Assignment Papers <i>(cover sheet &amp; document(s))</i></p> <p>9. <input type="checkbox"/> 37 CFR 3.73(b) Statement <i>(when there is an assignee)</i>      <input type="checkbox"/> Power of Attorney</p> <p>10. <input type="checkbox"/> English Translation Document <i>(if applicable)</i></p> <p>11. <input type="checkbox"/> Information Disclosure Statement (IDS)/PTO-1449      <input type="checkbox"/> Copies of IDS Citations</p> <p>12. <input type="checkbox"/> Preliminary Amendment</p> <p>13. <input checked="" type="checkbox"/> Return Receipt Postcard (MPEP 503) <i>(Should be specifically itemized)</i></p> <p>14. <input type="checkbox"/> Small Entity      <input type="checkbox"/> Statement filed in prior application Statement(s) Status still proper and desired</p> <p>15. <input type="checkbox"/> Certified Copy of Priority Document(s) <i>(if foreign priority is claimed)</i></p> <p>16. <input type="checkbox"/> Other: _____</p>		

17. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:

Continuation     Divisional     Continuation-in-part (CIP)    of prior application No. \_\_\_\_\_

**18. CORRESPONDENCE ADDRESS**

<input checked="" type="checkbox"/> Customer Number or Bar Code Label		<b>05514</b> <i>(Insert Customer No. or Attach bar code label here)</i>		or <input type="checkbox"/> Correspondence address below	
NAME					
Address					
City		State		Zip Code	
Country		Telephone		Fax	

CLAIMS	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
	TOTAL CLAIMS (37 CFR 1.16(c))	30-20 =	10	X \$ 18.00 =	\$ 180.00
	INDEPENDENT CLAIMS (37 cfr 1.16(b))	3-3 =	0	X \$ 78.00 =	\$ 0.00
	MULTIPLE DEPENDENT CLAIMS (if applicable) (37 CFR 1.16(d))			\$ 260.00 =	\$ 0.00
				BASIC FEE (37 CFR 1.16(a))	\$ 690.00
				Total of above Calculations =	\$ 870.00
	Reduction by 50% for filing by small entity (Note 37 CFR 1.9, 1.27, 1.28).				
				TOTAL =	\$ 870.00

19. Small entity status

- a.  A Small entity statement is enclosed
- b.  A small entity statement was filed in the prior nonprovisional application and such status is still proper and desired.
- c.  Is no longer claimed.

20.  A check in the amount of \$ 870.00 to cover the filing fee is enclosed.

21.  A check in the amount of \$ 40.00 to cover the recordal fee is enclosed.

22. The Commissioner is hereby authorized to credit overpayments or charge the following fees to Deposit Account No. 06-1205:

- a.  Fees required under 37 CFR 1.16.
- b.  Fees required under 37 CFR 1.17.
- c.  Fees required under 37 CFR 1.18.

**SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED**

NAME	Brian L. Klock - Reg. No. 36,570
SIGNATURE	
DATE	September 8, 2000

BLK\cmv

TITLE OF THE INVENTION

AUGMENTED REALITY PRESENTATION APPARATUS AND METHOD,  
AND STORAGE MEDIUM

5

FIELD OF THE INVENTION

The present invention relates to an augmented reality presentation apparatus and method, which superimposes a virtual object on a real space, and a  
10 storage medium.

More specifically, the present invention relates to an augmented reality presentation apparatus and method having a function of presenting a subjective augmented reality view for a player and generating a  
15 video of the same augmented reality space observed from an objective viewpoint, and a storage medium.

BACKGROUND OF THE INVENTION

A conventional augmented reality (AR) game system  
20 is constructed by an AR game apparatus for controlling an AR game, a head-mounted display (to be abbreviated as an HMD hereinafter) which the player of the AR game wears, and a display for presenting a subjective viewpoint video of the player to a third party other  
25 than the player.

- 100-00000000
- The AR game apparatus controls the AR game, and generates information that pertains to rendering of a virtual object at the same time. The AR game apparatus generates a composite video as a video obtained by
- 5 compositing a video of a virtual object generated using the information that pertains to rendering of the virtual object, and a video of a real space at the subjective viewpoint of the player, which is sensed by a camera attached to or built in the HMD.
- 10 The composite video is displayed on the display screen of the HMD. The player plays the AR game while reviewing this composite video. In addition to the player, the video at the subjective viewpoint of the player as this composite video is presented to a third
- 15 party who watches this AR game in addition to the player by displaying that video on a display prepared for a third party other than the player.
- Some TV programs use virtual studios in each of which a program stage set is built by virtual objects.
- 20 In this virtual studio, a program video is generated by compositing an actually sensed video of characters of the program sensed by a set camera, and a video of the virtual studio seen at the position and posture of that camera.
- 25 In the conventional AR (augmented reality) game system, a third party (watcher) other than the player

5

can only watch a video generated for the player (mainly at the subjective viewpoint of the player). For this reason, the watcher cannot watch videos of the AR game at viewpoints other than the subjective viewpoint of the player, e.g., the overall view of the AR game viewed from the objective viewpoint, a video of the AR game at a desired viewpoint of the watcher, and the like and can neither recognize the overall status of the AR game nor watch the AR game from a desired 10 viewpoint.

Also, a program video using a virtual studio is generated at the objective viewpoint of a third party other than the characters of the program, but a video viewed from the subjective viewpoint of each character 15 of the program cannot be generated.

It is, therefore, an object of the present invention to generate a video of an AR game at the subjective viewpoint of the player and also generate the overall view of the AR game viewed from an 20 objective viewpoint and a video of the AR game viewed from a desired viewpoint of the watcher.

#### SUMMARY OF THE INVENTION

In order to achieve the above object, an 25 augmented reality presentation apparatus described in

claim 1 as a preferred embodiment of the present invention comprises the following arrangement.

That is, augmented reality presentation means for superimposing the virtual object viewed from a player's  
5 viewpoint position in the real space viewed from said player's viewpoint position;

the first video sensing means for sensing a video of the real space viewed from a first viewpoint position which differ from said player's viewpoint  
10 position;

the first video generation means for generating a video of the virtual object viewed from said first viewpoint position;

and

15 the first video composition means for compositing an augmented reality video viewed from said first viewpoint position on the basis of said videos of the real space and the virtual object viewed from said first viewpoint position.

20 As a result, a video that reviews an operating state of a virtual object by the player in the augmented reality space from the objective viewpoint position can be generated and presented to a third party other than the player.

The augmented reality presentation apparatus as a preferred embodiment of the present invention further comprises the following feature described in claim 2.

That is, said augmented reality presentation  
5 means further comprises:

the second video sensing means for sensing a video of the real space viewed from said player's viewpoint position;

the second video generation means for generating  
10 a video of the virtual object viewed from said player's viewpoint position;

the second video composition means for compositing an augmented reality video viewed from said player's viewpoint position on the basis of said videos  
15 of the real space and the virtual object viewed from said player's viewpoint position;

and

the display means for displaying to the player  
the augmented reality video viewed from said player's  
20 viewpoint position.

The augmented reality presentation apparatus as a preferred embodiment of the present invention further comprises the following feature described in claim 3.

That is, said augmented reality presentation  
25 means further comprises:

the second video generation means for generating a video of the virtual object viewed from said player's viewpoint position;

and

5       the display means for displaying to the player the video of the virtual object viewed from said player's viewpoint position on a display surface through which the player can visually see the real space.

10      The augmented reality presentation apparatus as a preferred embodiment of the present invention further comprises the following feature described in claim 4.

That is, information generation means for generating information that pertains to rendering of 15 the virtual object, and

in that said first video generation means and said second video generation means generate videos of the virtual object using the information that pertains to rendering of the virtual object.

20      The augmented reality presentation apparatus as a preferred embodiment of the present invention further comprises the following feature described in claim 5.

That is, said information generation means generates information of an outer appearance of the 25 virtual object and information of a position/posture of

the virtual object as the information that pertains to rendering of the virtual object.

The augmented reality presentation apparatus as a preferred embodiment of the present invention further 5 comprises the following feature described in claim 6.

That is, parameters of said first video sensing means are known, and

said first video generation means generates the video of the virtual object viewed from said first 10 viewpoint position in accordance with the known parameters.

The augmented reality presentation apparatus as a preferred embodiment of the present invention further comprises the following feature described in claim 7.

15 That is, some of parameters of said first video sensing means are variable,

said apparatus further comprises measurement means for measuring changes of the parameters, and

20 said first video generation means generates the video of the virtual object viewed from said first viewpoint position in accordance with the parameters measured by said measurement means.

When the parameters of the objective viewpoint 25 video sensing means, the objective viewpoint video generation means receives parameters from the

measurement means, and generates an objective viewpoint video according to the received parameters.

The augmented reality presentation apparatus as a preferred embodiment of the present invention further  
5 comprises the following feature described in claim 8.

That is, the parameters of said first video sensing means measured by said measurement means include at least one of a viewpoint position/posture, and zoom ratio.

10 The objective viewpoint video of a virtual object is generated in accordance with camera parameters (external parameters (viewpoint position/posture) and internal parameters (zoom ratio, aspect ratio, optical axis central position, distortion ratio)) of the  
15 objective viewpoint video sensing means. The camera parameters measured by the measurement means preferably include all parameters to be changed dynamically of those parameters.

Other features and advantages of the present  
20 invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the figures thereof.

25

#### BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles 5 of the invention.

Fig. 1 is a view showing the first embodiment;

Fig. 2 is a block diagram showing the flow of processes of the first embodiment;

Fig. 3 is a diagram showing the generation 10 process of a coordinate conversion matrix used to convert the object coordinate position of a virtual object into an image coordinate position viewed from a given viewpoint;

Fig. 4 is a block diagram showing the flow of 15 processes of the third embodiment;

Fig. 5 is a view showing a video presented to a player in the first to fourth embodiments;

Fig. 6 is a view showing a video presented to a player in the fifth embodiment;

20 Fig. 7 is a block diagram showing the internal arrangement of an AR game apparatus;

Fig. 8 is a flow chart for generating a subjective viewpoint AR video and an objective viewpoint AR video;

25 Fig. 9 is a diagram showing a camera system used in the fourth embodiment;

Fig. 10 is a flow chart in the fourth embodiment;  
Fig. 11 is a flow chart in the fifth embodiment;  
Fig. 12 is a table showing camera parameters of a plurality of cameras in the fourth embodiment;  
5 Fig. 13 is a view for explaining an optical see-through HMD;  
Fig. 14 is a block diagram showing the flow of processes of the second embodiment;  
Fig. 15 is a block diagram showing the sixth embodiment; and  
10 Fig. 16 is a block diagram showing the seventh embodiment.  
Fig. 17 is a block diagram showing the flow of processes of the tenth embodiment.

15

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will now be described in detail in accordance with the accompanying drawings.

20 [First Embodiment]

As one preferred embodiment of the present invention, this embodiment will explain an augmented reality presentation apparatus and method, which present a state in which a player is playing an AR 25 (augmented reality) game in an AR space to a third

party (to be referred to as a watcher hereinafter) other than the player.

Fig. 1 shows this embodiment.

Reference numeral 101 denotes a player who is 5 playing an AR (augmented reality) game, and wears a head-mounted display (to be abbreviated as an HMD hereinafter) 107 on his or her head. Note that the HMD 107 in this embodiment is of video see-through type which possesses video camera(s) inside or on it to 10 capture the video(s) from the same viewpoint of the player's eye(s). Since the video see-through HMD is known to those who are skilled in the art, a detailed 15 description thereof will be omitted.

Reference numeral 102 denotes virtual objects as 15 characters which appear in the AR game. Each virtual object 102 is a three-dimensional virtual object rendered by computer graphics. The virtual objects 102 are generated by a method to be described later by an AR game apparatus 104. The player 101 can review a 20 video obtained by superimposing the virtual objects 102 on a real space (to be referred to as an AR video hereinafter) from his or her subjective viewpoint by wearing the HMD 107 on his or her head, and can consequently play the AR game.

25 Reference numeral 103 denotes an objective viewpoint video sensing camera (to be simply referred

to as a camera hereinafter) for sensing a state in which the player 101 is playing the AR game. In this embodiment, this camera 103 is fixed at a predetermined position and posture. A video sensed by the camera 103 5 (to be referred to as an objective viewpoint actually sensed video) is sent to the AR game apparatus 104 via a cable shown in Fig. 1. Note that the sensed video is an actually sensed video, which does not include any images of the virtual objects 102.

10 Reference numeral 104 denotes an AR game apparatus which controls the AR game, generates the videos of the virtual objects 102, and generates an AR video to be output to the HMD 107 and a display 106. Note that a video which the AR game apparatus 104 15 outputs to the HMD 107 is an AR video (to be referred to as a subjective viewpoint AR video hereinafter) obtained by compositing an actually sensed video of the real space (to be referred to as a subjective viewpoint actually sensed video hereinafter) input from the HMD 20 107, and videos of the virtual objects 102 viewed from the subjective viewpoint (to be referred to as subjective viewpoint virtual videos hereinafter). On the other hand, a video that the AR game apparatus 104 outputs to the display 106 is an AR video (to be 25 referred to as an objective viewpoint AR video hereinafter) obtained by compositing videos of the

virtual objects 102 viewed from the objective viewpoint (to be referred to as objective viewpoint virtual videos hereinafter), and the objective viewpoint actually sensed video sensed by the camera 103.

5 Reference numeral 105 denotes a table as a real object used as a stage in the AR game.

Reference numeral 106 denotes a display which displays the objective viewpoint AR video generated by the AR game apparatus 104 to present the playing state 10 of the AR game by the player 101 to a third party other than the player 101, as described above.

Reference numeral 107 denotes the aforementioned HMD which displays the subjective viewpoint AR video generated by the AR game apparatus 104 on its display 15 screen 501 shown in Fig. 5. Also, the HMD 107 senses the subjective viewpoint actually sensed video viewed from the subjective viewpoint of the player 101. The sensed video is sent to the AR game apparatus 104 via a cable shown in Fig. 1.

20 The flow of processes until the AR game apparatus 104 displays the subjective and objective AR videos respectively on the HMD 107 and display 106 based on the aforementioned arrangement will be explained below using Fig. 2 that shows the flow of such processes.

25 Reference numeral 201 denotes a game state manager incorporated in the AR game apparatus 104. The

game state manager 201 manages the state of the AR game (information that pertains to rendering of the virtual objects 102, the score of the player 101, AR game round count, and the like). Note that the information that 5 pertains to rendering of the virtual objects 102 includes information of the outer appearance of each virtual object 102, and information of the position/posture of each virtual object 102 in the world coordinate system.

10       The information of the outer appearance of each virtual object 102 is information that pertains to polygons which build the virtual object 102, i.e., the number of polygons, the coordinate values of polygons, the colors of polygons, and the like. When each 15 virtual object 102 has undergone texture mapping, the information of the outer appearance of each virtual object 102 includes a texture size, texture file name, and the like.

Reference numeral 204 denotes a camera parameter 20 measurement/management unit which measures/manages camera parameters as parameters of the HMD 107 and camera 103. The camera parameters to be managed by the camera parameter measurement/management unit 204 includes viewpoint position/posture information as 25 external parameters, and information of the field angle, focal length, distortion, and the like as internal

parameters. The camera parameter measurement/management unit 204 stores the internal parameters of the HMD 107 as known information. At the same time, the unit 204 measures the external parameters (information of the 5 viewpoint position and posture) of the HMD 107, and manages the camera parameters of the HMD 107.

Furthermore, the camera parameter measurement/management unit 204 manages camera parameters of the camera 103 as known information.

10 Reference numeral 202 denotes an objective viewpoint video generator built in the AR game apparatus 104. The objective viewpoint video generator 202 generates objective viewpoint virtual videos on the basis of the information that pertains to rendering of 15 the virtual objects 102, which is input from the game state manager 201.

Reference numeral 203 denotes an objective viewpoint video composition unit built in the AR game apparatus 104, which generates an objective viewpoint 20 AR video by compositing objective viewpoint virtual videos generated by the objective viewpoint video generator 202, and an objective viewpoint actually sensed video input from the camera 103.

Generation of the subjective viewpoint video will 25 be explained below.

The game state manager 201 updates the information that pertains to rendering of the virtual objects 102 as needed, and outputs the updated information to a subjective viewpoint video generator 212. The subjective viewpoint video generator 212 generates videos of the virtual objects 102 (subjective viewpoint virtual video) viewed from the viewpoint position/posture of the HMD107, on the basis of the information that pertains to rendering of the virtual objects 102, which is input from the game state manager 201, and the camera parameters of the HMD 107, which are input from the camera parameter measurement/management unit 204.

The generated subjective viewpoint virtual video is output to a subjective viewpoint video composition unit 213.

The subjective viewpoint video composition unit 213 receives from the HMD 107 the subjective viewpoint actually sensed video that the player 101 watches via the HMD 107. The subjective viewpoint video composition unit 213 generates a subjective viewpoint AR video as a composite video of this subjective viewpoint actually sensed video, and the subjective viewpoint virtual videos input from the subjective viewpoint video generator 212, and outputs that subjective viewpoint AR video to the HMD 107. The

subjective viewpoint AR video is displayed on the display screen 501 of the HMD 107, and the player 101 plays the AR game while reviewing this subjective viewpoint AR video.

- 5 Generation of an objective viewpoint video will be explained below.

The game state manager 201 updates the information that pertains to rendering of the virtual objects 102 as needed, and outputs the updated 10 information to the objective viewpoint video generator 202.

Since generation of the videos of the virtual objects 102 is implemented by the same processes as those in generation of the subjective viewpoint video, 15 a detailed description thereof will be omitted.

The generated objective viewpoint virtual video is output to the objective viewpoint video composition unit 203.

The objective viewpoint video composition unit 203 receives an objective viewpoint actually sensed video from the camera 103. The objective viewpoint video composition unit 203 generates an objective viewpoint AR video as a composite video of this objective viewpoint actually sensed video, and the 25 objective viewpoint virtual videos input from the objective viewpoint video generator 202, and outputs

the objective viewpoint AR video to the display 106. This objective viewpoint AR video is displayed on the display 106, and the watcher can see the overall view of the AR game by reviewing this objective viewpoint AR  
5 video and can recognize the current situation of the AR game.

The image coordinate values of the vertices of the polygons that build each virtual object 102 viewed from each viewpoint (HMD 107 or camera 103) can be  
10 computed using the coordinate conversion matrix M1 or M2 from the object coordinate system into the image coordinate system. The generation process of such coordinate conversion matrix will be explained below using the block diagram shown in Fig. 3.

15 A coordinate conversion matrix Mm from the object coordinate system into a world coordinate system is computed on the basis of the information of the position/posture of each virtual object 102. Also, coordinate conversion matrices Mc1 and Mc2 from the  
20 world coordinate system into the corresponding camera coordinate systems are respectively computed on the basis of information of the positions/postures of respective viewpoints included in the camera parameters of the HMD 107 and camera 103. Furthermore, coordinate  
25 conversion matrices Md1 and Md2 for implementing perspective conversions from the corresponding camera

coordinate systems into the image coordinate system are respectively computed on the basis of information such as the field angles, focal lengths, distortions, and the like included in the camera parameters of the HMD 5 107 and camera 103. The aforementioned coordinate conversion matrices are computed by the subjective viewpoint video generator 212 or objective viewpoint video generator 202.

The conversion matrix M1 from the object 10 coordinate system into the image coordinate system of the HMD 107 is given by:

$$M1 = Md1Mc1Mm$$

On the other hand, the conversion matrix M2 from the object coordinate system into the image coordinate 15 system of the camera 103 is given by:

$$M2 = Md2Mc2Mm$$

These computations are made by the subjective viewpoint video generator 212 or objective viewpoint video generator 202.

20 The present invention is not limit to these computations to make images. These computations are used, as factors that characterize subjective viewpoint and objective viewpoint.

The internal arrangement and operation of the AR 25 game apparatus 104 will be explained below using Fig. 7

00000000000000000000000000000000

that shows the internal block diagram of the AR game apparatus 104.

Reference numeral 701 denotes a CPU, which executes a program code loaded onto a RAM 703. The CPU 701 also has an area for temporarily saving data during execution of a program.

Reference numeral 702 denotes a ROM which stores setups upon and after starting up the AR game apparatus 104, and a startup program code. Also, the ROM 702 stores character codes and the like used to display on the display screen 501 a score or the like output to the HMD 107 during the AR game.

Reference numeral 703 denotes a RAM which stores a program code of the AR game loaded from a floppy disk, CD-ROM, or the like as an external storage medium, polygon and texture data that build each virtual object 102, and the like. Note that the game state manager 201 refers to and manages polygon (texture) data that build each virtual object 102, which are stored in the RAM 703.

Reference numeral 704 denotes an interface (to be abbreviated as an I/F hereinafter), which is used to connect the AR game apparatus 104 to an external apparatus. The HMD 107, camera 103, and display 106 are all connected to the AR game apparatus 104 via this I/F 704.

00000000000000000000000000000000

Reference numeral 705 denotes a console which comprises a keyboard and a pointing device such as a mouse or the like. This console 705 allows the user to input setup commands of the AR game apparatus 104, and 5 those for peripheral devices connected to the AR game apparatus 104.

Reference numeral 706 denotes a bus that connects the aforementioned units. Note that the game state manager 201, objective viewpoint video generator 202, 10 objective viewpoint video composition unit 203, subjective viewpoint video generator 212, subjective viewpoint video composition unit 213, and camera parameter measurement/management unit 204 are connected to this bus 706, and are controlled via the bus 706 on 15 the basis of the program code loaded onto the RAM 703, as described above.

When the CPU 701 executes the program code loaded onto the RAM 703, the game state manager 201, objective viewpoint video generator 202, objective viewpoint 20 video composition unit 203, subjective viewpoint video generator 212, subjective viewpoint video composition unit 213, and camera parameter measurement/management unit 204 execute the aforementioned processes, and output the subjective and objective viewpoint AR videos 25 to the HMD 107 and display 106, respectively. The flow

chart of this program code is shown in Fig. 8, and will be described below.

In step S801, the camera parameter measurement/management unit 204 updates the information 5 of the viewpoint position/posture of the HMD 107.

In step S802, the game state manager 201 updates the game state (information that pertains to rendering of the virtual objects 102).

10 In step S803, the objective and subjective viewpoint video generators 202 and 212 respectively generate objective and subjective viewpoint videos.

15 In step S804, the objective and subjective viewpoint video composition units 203 and 213 respectively receive actually sensed videos sensed by the HMD 107 and 103.

In step S805, the objective and subjective viewpoint video composition units 203 and 213 respectively generate objective and subjective viewpoint AR videos.

20 In step S806, the objective and subjective viewpoint video composition units 203 and 213 respectively output the objective and subjective viewpoint AR videos to the display 106 and HMD 107.

The aforementioned processes are repeated until 25 the AR game ends.

With the aforementioned arrangement of the apparatus, augmented reality presentation method, and program code, an objective viewpoint AR video can be presented to a third party other than the player 101 in the AR game using the video see-through HMD 107.

5 [Second Embodiment]

In the first embodiment, the HMD 107 is of video see-through type. However, if the HMD 107 is of optical see-through type, the player 101 can still play

10 the AR game.

Fig. 13 shows an optical see-through HMD 1301. Note that Fig. 13 schematically illustrates the HMD 1301, and the present invention is not limited to the size and shape shown in Fig. 13.

15 Reference numeral 1301 denotes an optical see-through HMD; and 1302, the eye of the player 101.

On the display screen 501, only videos of the virtual objects 102 (subjective viewpoint virtual videos) are displayed. On the other hand, a video of a real space is seen behind the display screen 501 when viewed from the position of the eye 1302. Hence, the player can review videos of the virtual objects 102 and the real space seen behind the display screen 501 when viewed from the position of the eye 1302 to overlap each other by observing the display screen 501.

Fig. 14 is a block diagram showing the flow of processes of this embodiment.

A video output from the AR game apparatus 104 to the HMD 1301 is a subjective viewpoint virtual video 5 alone, as described above. Hence, the HMD 1301 and subjective viewpoint video generator 212 are electrically connected via a cable, and a subjective viewpoint virtual video which is generated by the subjective viewpoint video generator 212 on the basis 10 of the position and posture of the HMD 1301 is sent from the subjective viewpoint video generator 212 to the HMD 1301. Note that this embodiment has no subjective viewpoint video composition unit 213 in the first embodiment.

15 Also, the method of generating an objective viewpoint AR video is the same as that which has been explained in the first embodiment.

The internal block diagram of the AR game apparatus 104 in this embodiment is substantially the 20 same as that shown in Fig. 7, except that the objective viewpoint video composition unit 213 is removed from the arrangement shown in Fig. 7.

In the flow chart of this embodiment, steps S804, 25 S805, and S806 in Fig. 8 are rewritten as follows. More specifically, upon generating a subjective viewpoint AR video (only videos of the virtual objects

102 based on the position and posture of the HMD 1301  
in this embodiment) to be displayed on the HMD 1301,  
steps S804 and S805 are skipped. That is, in step S804  
the objective viewpoint video composition unit 203  
5 receives an actually sensed video sensed by the camera  
103. In step S805, the objective viewpoint video  
composition unit 203 generates an objective viewpoint  
AR video. In step S806, the objective viewpoint video  
composition unit 203 outputs the objective viewpoint AR  
10 video to the display 106, and the subjective viewpoint  
video generator 212 outputs a subjective viewpoint  
virtual video to the HMD 1301.

The flow chart obtained by modifying the contents  
of Fig. 8 as described above is that in this embodiment,  
15 and this embodiment is controlled by a program code  
according to this modified flow chart.

With the aforementioned arrangement of the  
apparatus, augmented reality presentation method, and  
program code, an objective viewpoint AR video can be  
20 presented to a third party other than the player 101 in  
the AR game using the optical see-through HMD 1301.

[Third Embodiment]

In the first and second embodiments, the camera  
parameters of the camera 103 are fixed. That is, an  
25 objective viewpoint AR video is generated based on the  
camera parameters of the camera 103 which is fixed in

position. The camera parameter data of the camera 103 are stored as permanent values in the RAM 703 of the AR game apparatus 104.

A case will be examined below wherein the viewpoint position, posture, and zooming ratio of the camera 103 are changed in real time to those that the player or a third party other than the player 101(watcher or operator) wants. That is, a case will be examined below wherein the camera parameters of the camera 103 are changed in real time. Note that this embodiment uses a video see-through HMD as in the first embodiment. However, the HMD that can be used in this embodiment is not limited to the video see-through type, but an optical see-through HMD may be used, as can be seen from the description of the second embodiment and this embodiment.

When the position, posture, and zooming ratio of the camera 103 are to be changed in real time, a measurement means as a means for measuring the position, posture, and zooming ratio of the camera 103 must be added to the first embodiment.

Fig. 4 is a block diagram showing the flow of processes in this embodiment. The flow of processes in this embodiment will be described below using Fig. 4.

Like in the first embodiment, in this embodiment the camera parameter measurement/management unit 204

measures and manages the camera parameters of the HMD 107, and holds some internal parameters of the camera 103 as known information. Unlike in the first embodiment, in this embodiment the camera parameter 5 measurement/management unit 204 controls a sensor (not shown) attached to the camera 103 to measure the position, posture, and zooming ratio of the camera 103.

When the player 101 has changed the position, posture, and zooming ratio of the camera 103 via an 10 interface (not shown), the camera parameter measurement/management unit 204 measures the position, posture, and zooming ratio of the camera 103. The measurement result data (the position, posture, and zooming ratio data of the camera 103) by the camera 15 parameter measurement/management unit 204, and the known internal parameters are output to the objective viewpoint video generator 202. The objective viewpoint video generator 202 generates an objective viewpoint virtual video on the basis of the input camera 20 parameters of the camera 103 in the same manner as in the process in the first embodiment. Other processes are the same as those in the first embodiment.

A control program code of the interface that changes the position, posture, and zooming ratio of the 25 camera 103, and a control program code of the camera

parameter measurement/management unit 204 are stored in the RAM 703 of the AR game apparatus 104.

The flow chart of this embodiment is the same as that shown in Fig. 8. However, in this embodiment the 5 camera parameter measurement/management unit 204 updates the information of the viewpoint position and posture of the HMD 107 and the information of the viewpoint position, posture, and the zooming ratio of the camera 103 in step S801.

10 Internal parameter (zooming ratio) is fixed, position and posture may be variable. With the aforementioned arrangement of the apparatus, augmented reality presentation method, and program code, an objective viewpoint AR video can be generated based on 15 data from the camera whose position and posture change.  
[Fourth Embodiment]

In the first to third embodiments, only one camera is set. Alternatively, when a plurality of cameras are set and the camera to be used is switched, 20 objective viewpoint AR videos from a plurality of positions and postures can be displayed on the display 106.

Fig. 9 shows a camera system in this embodiment. The camera system will be explained below using Fig. 9. 25 Note that this embodiment sets three cameras.

Reference numerals 901a, 901b, and 901c denote cameras (cameras 901a, 901b, and 901c), the camera parameters (positions, postures, field angles, and the like) of which are fixed. The functions of these

5 cameras are the same as those in the first and second embodiments. The camera parameters of these three cameras are set, as shown in Fig. 12, and these three sets of data are stored in the RAM 703 of the AR game apparatus 104 and are managed by the camera parameter

10 measurement/management unit 204.

Note that reference numerals 1201, 1202, and 1203 in Fig. 12 denote (selection information) tags corresponding to the cameras 901a, 901b, and 901c, which are used to select the camera to be used.

15 Reference numeral 902 denotes a camera switching device, which has a function of a switcher that sends only a signal (actually sensed video of a real space sensed by the selected camera) from the camera selected by a selector 903 to the video composition unit 203 via

20 the switching device 902.

Reference numeral 903 denotes a selector which has the aforementioned function, and has three buttons (buttons A, B, and C) corresponding to the three cameras. When the user selectively presses one of

25 these buttons, he or she can select the camera to be used. The selector 903 outputs selection information

indicating the camera selected to the switching device 902 and camera parameter measurement/management unit 204. Note that the cameras 901a, 901b, and 901c are respectively selected by pressing buttons A, B, and C 5 in Fig. 9 as the camera to be used.

The camera parameter measurement/management unit 204 selects the tag (one of the tags 1201, 1202, and 1203) of the camera mentioned above in accordance with the camera selection information input from the 10 selector 903, and outputs the camera parameters of the selected camera to the objective viewpoint video generator 202. For example, when the camera 901b is used, the camera parameters of the camera 901b held by the tag 1202 are output to the objective viewpoint 15 video generator 202 upon depression of button B.

Fig. 10 is a flow chart showing the process of this embodiment.

It is checked in step S1001 if one of the buttons of the selector 903 has been pressed. Note that this 20 process is repeated until one of the buttons is pressed.

In steps S1002, S1003, and S1004, the button pressed is determined. Assuming that button B has been pressed, the flow advances from step S1003 to step S1006.

25 In steps S1005, S1006, and S1007, an actually sensed video sensed by the camera corresponding to the

pressed button is sent to the objective viewpoint video composition unit 203 via the switching device 902.

Also, the selection information of the camera corresponding to the pressed button is sent to the  
5 camera parameter measurement/management unit 204.

A program code according to the aforementioned flow chart is stored in the internal memory (not shown) of the switching device 902.

Camera switching may be automatically performed  
10 in accordance with the progress of a game. In this case, the selector 903 is omitted, and the game state manager 201 outputs camera selection information to the camera switching device 902 and the camera parameter measurement/management unit 204. Camera switching can  
15 employ a method of switching cameras every predetermined time interval or a method of switching cameras in accordance with the progress of a scenario by presetting a camera having an appropriate camera angle every time the scenario progresses.

20 In this embodiment, the camera parameters of the three cameras are fixed. Alternatively, when the camera parameters of these cameras change in real time, the aforementioned arrangement of the apparatus, augmented reality presentation method, and program code  
25 can be applied. In this case, such application can be implemented by connecting the camera system of this

embodiment to the AR game apparatus 104 in place of the camera 103 in the third embodiment.

With the aforementioned arrangement of the apparatus, augmented reality presentation method, and 5 program code, a plurality of objective viewpoint AR videos sensed by a plurality of cameras can be displayed on the display 106.

[Fifth Embodiment]

In the first to fourth embodiments, an objective 10 viewpoint AR video is presented to a third party other than the player via the display 106 by outputting it to the display 106. Alternatively, the objective viewpoint AR video may be presented to the player 101. That is, a display area 601 shown in Fig. 6 is assured 15 on the display screen 501 of the HMD (which can be of either video or optical see-through type) that the player 101 wears, and the objective viewpoint AR video is displayed there. In Fig. 6, a video displayed on this display screen 501 will be referred to as an 20 augmented video hereinafter.

In order to generate this augmented video, a program code for setting the display area 601 on the display screen 501, and writing an objective viewpoint AR video on that display area 601 is stored in the RAM 25 703 of the AR game apparatus 104 in addition to the program code according to the flow chart shown in

Fig. 8. As a result, by executing this program code, the augmented video can be displayed on the display screen 501.

Fig. 11 is a flow chart of the program code for writing the objective viewpoint AR video on the display area 601 mentioned above.

It is checked in step S1101 if the display area 601 is assured. Selection as to whether or not the display area 601 is assured can be implemented by providing this selection switch to an operation device (not shown) used when the player 101 plays the AR game. Or such selection can be implemented by inputting a command indicating whether or not the display area 601 is assured from the console 705.

In step S1102, the display position of the display area 601 is input. The display position is input from the console 705. Alternatively, the player 101 may input the display position using the aforementioned operation device.

In step S1103, the size of the display area 601 is input. The size is input from the console 705. Alternatively, the player 101 may input the size using the aforementioned operation device.

In step S1104, the display area 601, the setups of which have been determined in steps S1102 and S1103, is assured on the display screen 501.

In step S1105, the objective viewpoint AR video generated by the objective viewpoint video composition unit 203 is rendered on the display area 601. As a consequence, the augmented video can be generated.

5 Note that this augmented video may be output to the display 106.

Selection of whether the display area 601 is set and the display position and size of the display area 601 may be automatically set/changed not by the player 10 but in accordance with the progress of the game. In this case, the game state manager 201 determines these parameters.

The display area 601 may be the entire area of the display screen 501.

15 With the aforementioned arrangement of the apparatus, augmented reality presentation method, and program code, both the subjective and objective viewpoint AR videos can be presented to the player.

[Sixth Embodiment]

20 A plurality of players 101 may join the AR game. In this case, subjective viewpoint AR videos from individual subjective viewpoints must be provided to the individual players. Fig. 15 shows the internal arrangement of the AR game apparatus for providing 25 subjective viewpoint AR videos from the players' subjective viewpoints to the individual players. Note

that the camera 103 is fixed in position, and the processes that pertain to the camera 103 and display are the same as those in the first embodiment.

Fig. 15 shows the internal arrangement for three 5 players. Hence, the AR game apparatus 104 comprises HMDs 107A, 107B, and 107C, subjective viewpoint video composition units 213A, 213B, and 213C, and subjective viewpoint video generators 212A, 212B, and 212C in correspondence with three players a, b, and c. Three 10 players a, b, and c respectively wear the HMDs 107A, 107B, and 107C. This embodiment uses a video see-through HMD, but an optical see-through HMD may be used. In this case, the subjective viewpoint video composition units for the three HMDs can be omitted.

15 When the AR game starts, the HMDs, subjective viewpoint video generators, and subjective viewpoint video composition units execute the same processes as those described in the first embodiment, and subjective viewpoint AR videos generated for the individual 20 players are output to the HMDs 107A, 107B, and 107C that the players wear.

Note that the aforementioned arrangement of the apparatus and augmented reality presentation method are not limited to three players, as is obvious from the 25 above description.

With the aforementioned arrangement of the apparatus and augmented reality presentation method, subjective viewpoint AR videos can be provided to a plurality of players.

5 [Seventh Embodiment]

In the fourth embodiment, a plurality of cameras 103 are set, but only one display 106 for displaying an objective viewpoint AR video is used.

However, the number of displays 106 is not limited to one, but a plurality of displays 106 may be used. That is, when objective viewpoint AR videos from the respective cameras 103 are separately displayed on a plurality of displays 106, the objective viewpoint AR videos from all the cameras 103 can be presented to a third party other than the player 101 using a plurality of displays 106.

In this embodiment, a case will be described below wherein a plurality of cameras 103 and a plurality of displays 106 are set. Fig. 16 shows the internal arrangement of the AR game apparatus 104 for displaying objective viewpoint AR videos from a plurality of cameras 103 on a plurality of displays 106.

In Fig. 16, three cameras 103A, 103B, and 103C are set, and displays 106A, 106B, and 106C for respectively displaying objective viewpoint AR videos from the cameras 103A, 103B, and 103C are set. Also,

the AR game apparatus 104 comprises objective viewpoint video generators 202A, 202B, and 202C, and objective viewpoint video composition units 203A, 203B, and 203C corresponding to the displays 106A, 106B, and 106C so  
5 as to generate objective viewpoint AR videos corresponding to the displays 106A, 106B, and 106C.

When the AR game starts, the cameras, objective viewpoint video generators, and objective viewpoint video composition units execute the same processes as  
10 those in the first embodiment, and objective viewpoint AR videos from the cameras 103A to 103C are displayed on the displays 106A to 106C corresponding to these cameras 103A to 103C.

Note that the aforementioned arrangement of the  
15 apparatus and augmented reality presentation method are not limited to three displays 106, as is obvious from the aforementioned description.

With the aforementioned arrangement of the apparatus and augmented reality presentation method,  
20 all objective viewpoint AR videos from a plurality of cameras 103 can be presented to a third party other than the player 101 using a plurality of displays 106.

#### [Eighth Embodiment]

An apparatus that offers an AR video to the  
25 player 101 may be other than the game apparatus. That is, an AR apparatus which has substantially the same

FIFTEEN PAGES

internal arrangement as that of the AR game apparatus 104 and stores a program code for implementing shopping in an AR space in place of a game program code may be used in place of the AR game apparatus 104. As a 5 result, the player 101 can browse among presented products in shopping by observing a subjective viewpoint AR video from the AR apparatus, and that state is displayed on the display 106 as an objective viewpoint AR video.

10 Note that these subjective and objective viewpoint AR videos can be generated in the same manner as in the above embodiments.

[Ninth Embodiment]

When the camera parameters such as the position, 15 posture, zoom ratio, and the like of the camera change, they may be estimated from an actually sensed video input from the camera 103 in place of the sensor. In this case, the camera parameter measurement/management unit 204 receives an actually sensed video, and 20 estimates camera parameters by a known method. In consideration of estimation errors, the camera parameters measured by the sensor and those estimated by the camera parameter measurement/management unit 204 may be averaged to determine camera parameters to be 25 used finally.

[Tenth Embodiment]

The generated objective viewpoint AR video can be  
not only displayed on the display 106 but also printed  
on a medium such as paper or a film. In this case, a  
print controller 301 (print control apparatus 301) and  
5 a printer 302 are added to the arrangement shown in  
each of the first to seventh embodiments. The 10th  
embodiment will be described with reference to Fig. 17  
by exemplifying the arrangement of the first embodiment.

In the 10th embodiment, an objective viewpoint AR  
10 video output from an objective viewpoint video  
composition unit 203 is output to the printer  
controller 301 as well as the display 106. The print  
controller 301 stores the objective viewpoint AR video  
input at this time point and outputs the stored image  
15 to the printer 302 in accordance with a command input  
from a console 705. The printer 302 prints the input  
image on paper.

As in the seventh embodiment, when a plurality of  
objective viewpoint video composition units 203 are  
20 used, the print controller 301 receives objective  
viewpoint AR videos respectively output from the  
objective viewpoint video composition units 203. In  
this case, in accordance with a command input from the  
console 705 the print controller 301 selects an  
25 objective viewpoint AR video having a specific  
viewpoint, stores the objective viewpoint AR video

input at this time point, and outputs the stored image to the printer 302. It is possible to print the subjective viewpoint AR video of each embodiment described above in accordance with the same processing 5 as described above. In this case, a subjective viewpoint video composition unit 213 outputs the subjective viewpoint AR video to an HMD 107 and at the same time to the print controller 301.

It is also possible to simultaneously print 10 objective viewpoint AR videos viewed from a plurality of viewpoint positions, objective viewpoint AR videos viewed from the same viewpoint at different times, or subjective viewpoint AR videos of the respective players on one paper sheet. In this case, the print 15 controller 301 selects a viewpoint in accordance with a command input from the console 705 and stores the AR video viewed from the selected viewpoint. The print controller 301 determines a layout for printing a plurality of stored images on one paper sheet in accordance with a command input from the console 705 20 and outputs them to the printer 302.

The command may be automatically input to the print controller 301 in accordance with the progress of a game without using the console 705. In this case, a 25 game state manager 201 transmits a command to the print controller 301. The command may be transmitted at a

00000000000000000000000000000000

fixed timing preset in accordance with the progress of  
the game or a dynamic timing corresponding to the  
progress of the game such that the distance between the  
player and a virtual object 102 becomes a predetermined  
5 interval or less.

The camera 103 (or camera 901) can be located at  
an arbitrary position. The third party can easily  
grasp the state of the game when the camera is located  
at a position where the entire AR space can be observed  
10 from the bird-view position or a position where the  
upper half image (so-called bust shot) of the player  
can be sensed from the front.

As described above, according to the present  
invention, a video of the AR game viewed from the  
15 subjective viewpoint of the player can be generated,  
and, simultaneously, a video of the AR game viewed from  
an objective viewpoint to see the overall view of the  
game field or a video of the AR game viewed from a  
viewpoint the watcher wants can be generated.

20 As many apparently widely different embodiments  
of the present invention can be made without departing  
from the spirit and scope thereof, it is to be  
understood that the invention is not limited to the  
specific embodiments thereof except as defined in the  
25 appended claims.

WHAT IS CLAIMED IS:

1. An augmented reality presentation apparatus for superimposing a virtual object in a real space, characterized by comprising:

5        augmented reality presentation means for superimposing the virtual object viewed from a player's viewpoint position in the real space viewed from said player's viewpoint position;

10      the first video sensing means for sensing a video of the real space viewed from a first viewpoint position which differ from said player's viewpoint position;

15      the first video generation means for generating a video of the virtual object viewed from said first viewpoint position;

and

the first video composition means for compositing an augmented reality video viewed from said first viewpoint position on the basis of said videos of the 20 real space and the virtual object viewed from said first viewpoint position.

2. The apparatus according to claim 1, characterized in that said augmented reality presentation means further comprises:

(2)

the second video sensing means for sensing a video of the real space viewed from said player's viewpoint position;

5       the second video generation means for generating a video of the virtual object viewed from said player's viewpoint position;

10      the second video composition means for compositing an augmented reality video viewed from said player's viewpoint position on the basis of said videos of the real space and the virtual object viewed from said player's viewpoint position;

and

15      the display means for displaying to the player the augmented reality video viewed from said player's viewpoint position.

3.       The apparatus according to claim 1, characterized in that said augmented reality presentation means further comprises:

20      the second video generation means for generating a video of the virtual object viewed from said player's viewpoint position;

and

25      the display means for displaying to the player the video of the virtual object viewed from said player's viewpoint position on a display surface

through which the player can visually see the real space.

4. The apparatus according to claim 1, characterized  
5 by further comprising information generation means for  
generating information that pertains to rendering of  
the virtual object, and

in that said first video generation means and  
said second video generation means generate videos of  
10 the virtual object using the information that pertains  
to rendering of the virtual object.

5. The apparatus according to claim 4, characterized  
in that said information generation means generates  
15 information of an outer appearance of the virtual  
object and information of a position/posture of the  
virtual object as the information that pertains to  
rendering of the virtual object.

20 6. The apparatus according to claim 1, characterized  
in that parameters of said first video sensing means  
are known, and

25 said first video generation means generates the  
video of the virtual object viewed from said first  
viewpoint position in accordance with the known  
parameters.

7. The apparatus according to claim 1, characterized in that some of parameters of said first video sensing means are variable,

5 said apparatus further comprises measurement means for measuring changes of the parameters,  
and

10 said first video generation means generates the video of the virtual object viewed from said first viewpoint position in accordance with the parameters measured by said measurement means.

8. The apparatus according to claim 7,  
characterized in that the parameters of said first  
15 video sensing means measured by said measurement means include at least one of a viewpoint position/posture, and zoom ratio.

9. The apparatus according to claim 1, characterized  
20 in that when a plurality of first video sensing means equivalent to said first video sensing means are present,

25 said apparatus further comprises selection means for receiving a plurality of videos of the real space from said first viewpoint position from the plurality of first video sensing means, and outputting a video of

the real space viewed from said first viewpoint position input from one selected first video sensing means to said first video composition means, and

said first video composition means generates a  
5 video of the virtual object viewed from said first viewpoint position using parameters of the first video sensing means selected by said selection means.

10. An augmented reality presentation method for  
10 superimposing a virtual object in a real space,  
characterized by comprising:

augmented reality presentation step of  
superimposing the virtual object viewed from a player's  
viewpoint position in the real space viewed from said  
15 player's viewpoint position;

the first video sensing step of sensing a video  
of the real space viewed from a first viewpoint  
position which differ from said player's viewpoint  
position;

20 the first video generation step of generating a  
video of the virtual object viewed from said first  
viewpoint position;

and

the first video composition step of compositing  
25 an augmented reality video viewed from said first  
viewpoint position on the basis of said videos of the

real space and the virtual object viewed from said first viewpoint position.

11. The method according to claim 10, characterized  
5 in that the augmented reality presentation step further comprises:

the second video sensing step of sensing a video of the real space viewed from said player's viewpoint position;

10 the second video generation step of generating a video of the virtual object viewed from said player's viewpoint position;

15 the second video composition step of compositing an augmented reality video viewed from said player's viewpoint position on the basis of said videos of the real space and the virtual object viewed from said player's viewpoint position;

and

20 the display step of displaying to the player the augmented reality video viewed from said player's viewpoint position.

12. The method according to claim 10, characterized  
in that the augmented reality presentation step further  
25 comprises:

the second video generation step of generating a video of the virtual object viewed from said player's viewpoint position;

and

5       the display step of displaying to the player the video of the virtual object viewed from said player's viewpoint position on a display surface through which the player can visually see the real space.

10      13.   The method according to claim 10, characterized by further comprising the information generation step of generating information that pertains to rendering of the virtual object,

and

15      in that in said first video generation step and said second video generation step, videos of the virtual object are generated using the information that pertains to rendering of the virtual object.

20      14.   The method according to claim 13, characterized in that said information generation step includes the step of generating information of an outer appearance of the virtual object and information of a position/posture of the virtual object as the  
25      information that pertains to rendering of the virtual object.

15. The method according to claim 10, characterized  
in that parameters of means for sensing said first  
viewpoint video are known, and

5           said first video generation step includes the  
step of generating the video of the virtual object  
viewed from said first viewpoint position in accordance  
with the known parameters.

10       16. The method according to claim 10, characterized  
in that some of parameters of means for sensing a video  
viewed from said first viewpoint position are variable,  
          said method further comprises the measurement  
step of measuring changes of the parameters,

15       and

          said first video generation step includes the  
step of generating the video of the virtual object  
viewed from said first viewpoint position in accordance  
with the parameters measured in the measurement step.

20

17. The method according to claim 16, characterized  
in that the parameters of the means for sensing a video  
viewed from said first viewpoint position measured in  
the measurement step include at least one of a  
25     viewpoint position/posture, and zoom ratio.

18. The method according to claim 10, characterized  
in that when a plurality of means for sensing a video  
viewed from said first viewpoint position are present,  
said method further comprises the selection step  
5 of receiving a plurality of videos of the real space  
viewed from a first viewpoint position from the  
plurality of means for sensing a video viewed from said  
first viewpoint position, and outputting the video of  
the real space viewed from a first viewpoint position  
10 input from one selected means for sensing a video of  
said first viewpoint position to means for compositing  
a first viewpoint video, and

15 said first video composition step includes the  
step of generating a video of the virtual object viewed  
from said first viewpoint position using parameters of  
the means for sensing a video viewed from a first  
viewpoint position selected in the selection step.

19. A storage medium storing a program code for  
20 superimposing a virtual object in a real space when  
said program code is loaded by a computer,  
characterized by comprising:

25 a program code of the augmented reality  
presentation step of superimposing the virtual object  
viewed from a player's viewpoint position in the real  
space viewed from said player' viewpoint position;

a program code of the first video sensing step of sensing a video of the real space viewed from a first viewpoint position which differ from said player's viewpoint position;

5 a program code of the first video generation step of generating a video of the virtual object viewed from said first viewpoint position;

and

10 a program code of the first video composition step of compositing an augmented reality video viewed from said first viewpoint position on the basis of said videos of the real space and the virtual object viewed from said first viewpoint position.

15 20. The medium according to claim 19, characterized in that the program code of the augmented reality presentation step further comprises:

20 a program code of the second video sensing step of sensing a video of the real space viewed from said player's viewpoint position;

a program code of the second video generation step of generating a video of the virtual object viewed from said player's viewpoint position;

25 a program code of the second video composition step of compositing an augmented reality video viewed from said player's viewpoint position on the basis of

RECORDED - INDEXED  
said videos of the real space and the virtual object viewed from said player's viewpoint position; and

a program code of the display step of displaying 5 to the player the augmented reality video viewed from said player's viewpoint position.

21. The medium according to claim 19, characterized in that the program code of the augmented reality 10 presentation step further comprises:

a program code of the second video generation step of generating a video of the virtual object viewed from said player's viewpoint position; and

15 a program code of the display step of displaying to the player the video of the virtual object viewed from said player's viewpoint position on a display surface through which the player can visually see the real space.

20

22. The medium according to claim 19, characterized by further comprising a program code of the information generation step of generating information that pertains to rendering of the virtual object,

25 and

in that in the program codes of said first video generation step and said second video generation step, videos of the virtual object are generated using the information that pertains to rendering of the virtual object.

23. The medium according to claim 22, characterized  
in that the program code of said information generation  
step includes the step of generating information of an  
outer appearance of the virtual object and information  
of a position/posture of the virtual object as the  
information that pertains to rendering of the virtual  
object.

15 24. The medium according to claim 19, characterized  
in that parameters of means for sensing said first  
viewpoint video are known, and

the program code of said first video generation step includes the step of generating the video of the virtual object viewed from said first viewpoint position in accordance with the known parameters.

25. The medium according to claim 19, characterized  
in that some of parameters of means for sensing a video  
25 viewed from said first viewpoint position are variable,

the program code of said medium further comprises  
the measurement step of measuring changes of the  
parameters,  
and

5 the program code of said first video generation  
step includes the step of generating the video of the  
virtual object viewed from said first viewpoint  
position in accordance with the parameters measured in  
the measurement step.

10  
26. The medium according to claim 25, characterized  
in that the parameters of the means for sensing a video  
viewed from said first viewpoint position measured in  
the measurement step include at least one of a  
15 viewpoint position/posture, and zoom ratio.

27. The medium according to claim 19, characterized  
in that when a plurality of means for sensing a video  
viewed from said first viewpoint position are present,  
20 said medium further comprises a program code of  
the selection step of receiving a plurality of videos  
of the real space viewed from a first viewpoint  
position from the plurality of means for sensing a  
video viewed from said first viewpoint position, and  
25 outputting the video of the real space viewed from a  
first viewpoint position input from one selected means

for sensing a video of said first viewpoint position to means for compositing a first viewpoint video, and the program code of said first video composition step includes the step of generating a video of the 5 virtual object viewed from said first viewpoint position using parameters of the means for sensing a video viewed from a first viewpoint position selected in the selection step.

10 28. The apparatus according to claim 1, characterized by further comprising printing means,

in that said first video composition means outputs the augmented reality video to said printing means,

15 said printing means grabs one frame of the received video and prints out to the paper as a still image.

20 29. The method according to claim 10, characterized by further comprising printing step,

in that in said first video composition step the augmented reality video is output to means for printing,

in said printing step one frame of the received video is grabbed and printed out to the paper as a 25 still image.

30. The method according to claim 19, characterized by further comprising a program code of the printing step,

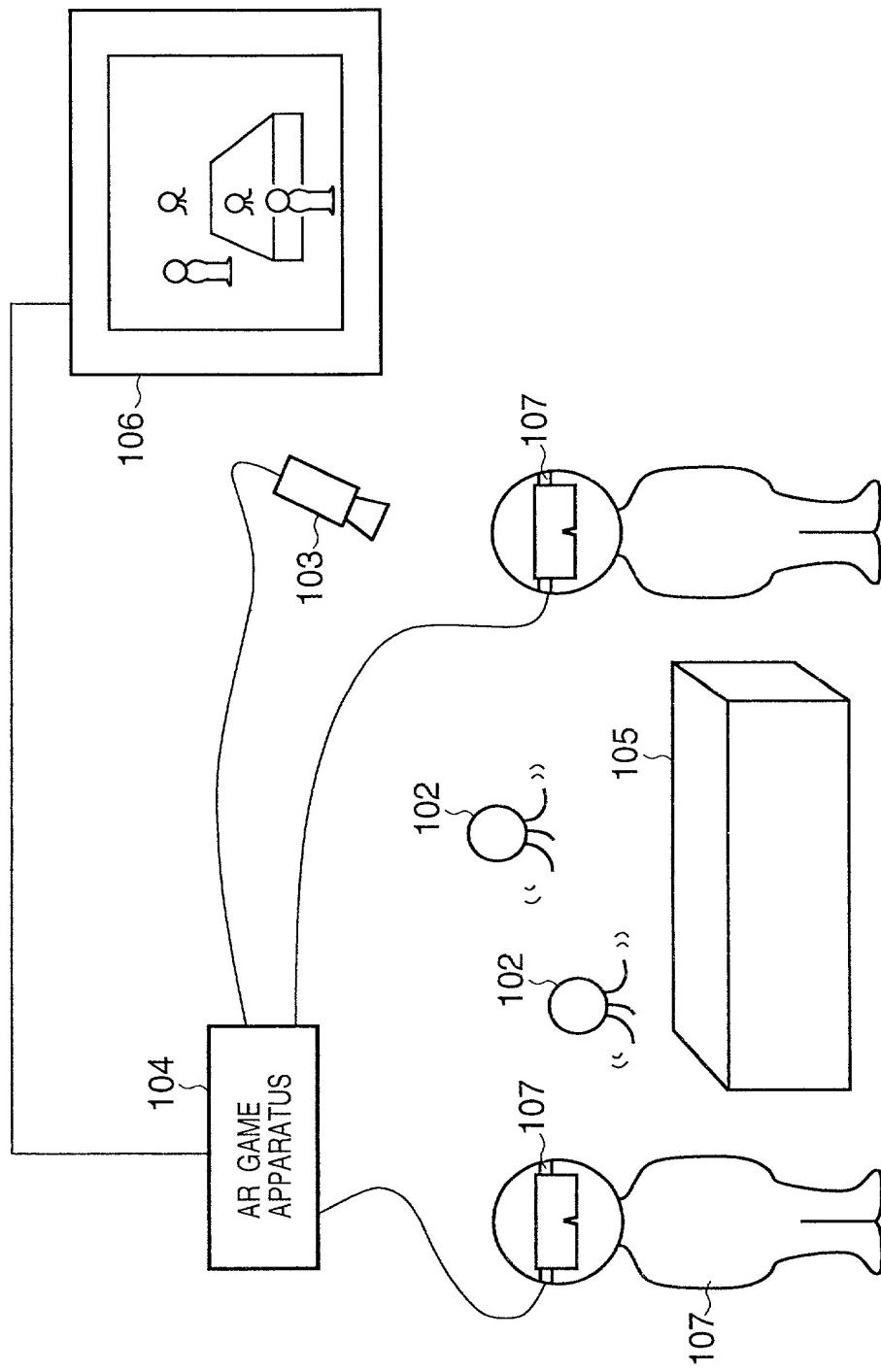
in that in the program codes of said first video  
5 composition step the augmented reality video is output to means for printing,

in the program codes of said printing step one frame of the received video is grabbed and printed out to the paper as a still image.

ABSTRACT OF THE DISCLOSURE

A game state manager (201) manages the state of an AR game (information that pertains to rendering of 5 each virtual object (102), the score of a player (101), the AR game round count, and the like). An objective viewpoint video generator (202) generates a video of each virtual object (102) viewed from a camera (103). An objective viewpoint video composition unit (203) 10 generates a composite video of the video of the virtual object (102) and an actually sensed video, and outputs it to a display (106). A subjective viewpoint video generator (212) generates a video of the virtual object (102) viewed from an HMD (107). A subjective viewpoint 15 video composition unit (213) generates a composite video of the video of the virtual object (102) and an actually sensed video, and outputs it to the HMD (107).

**FIG. 1**



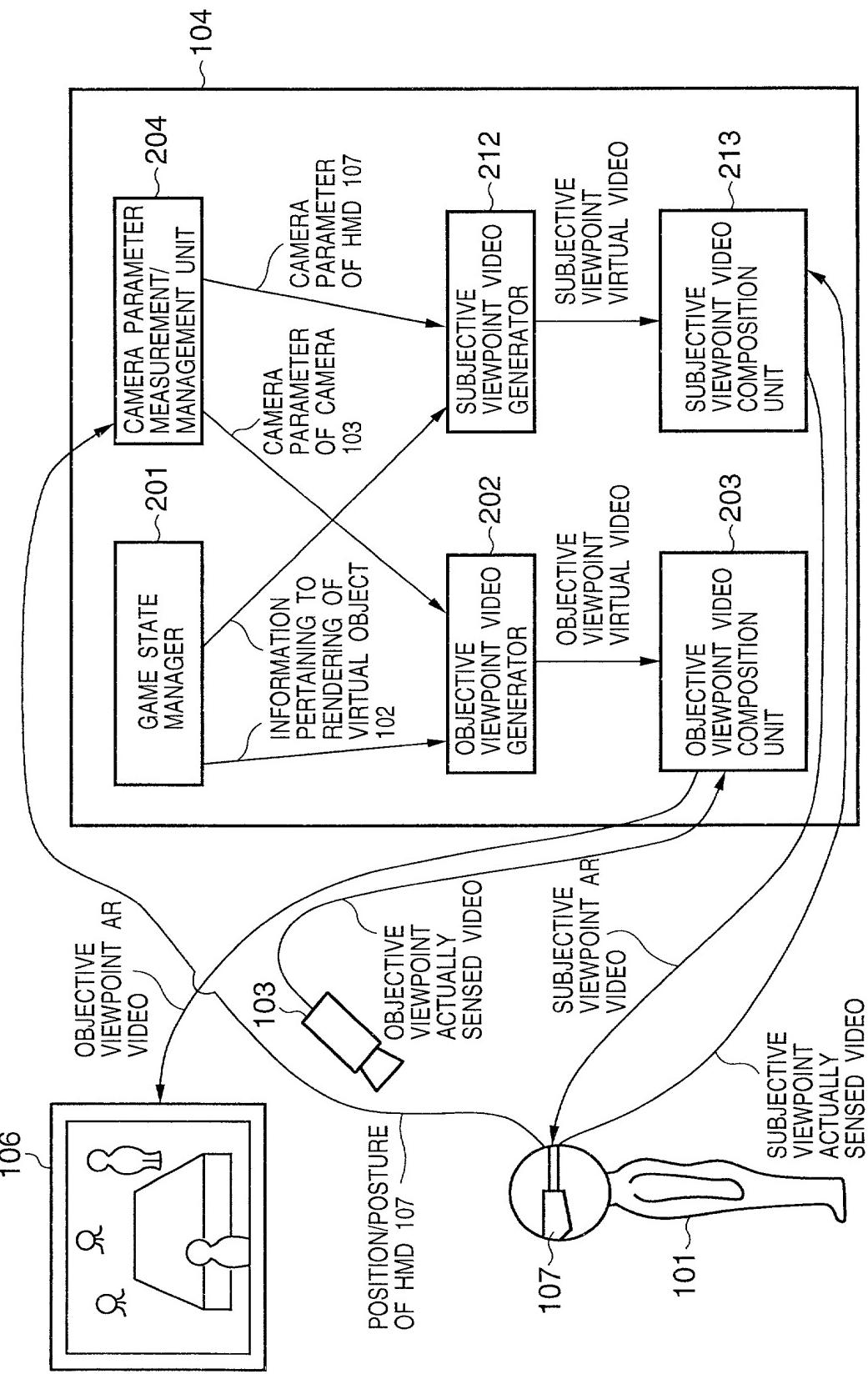
**FIG. 2**

FIG. 3

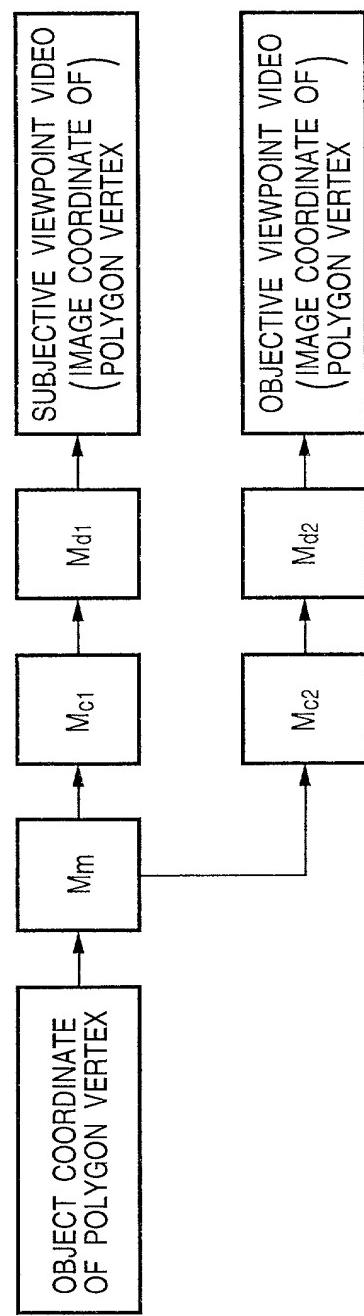


FIG. 4

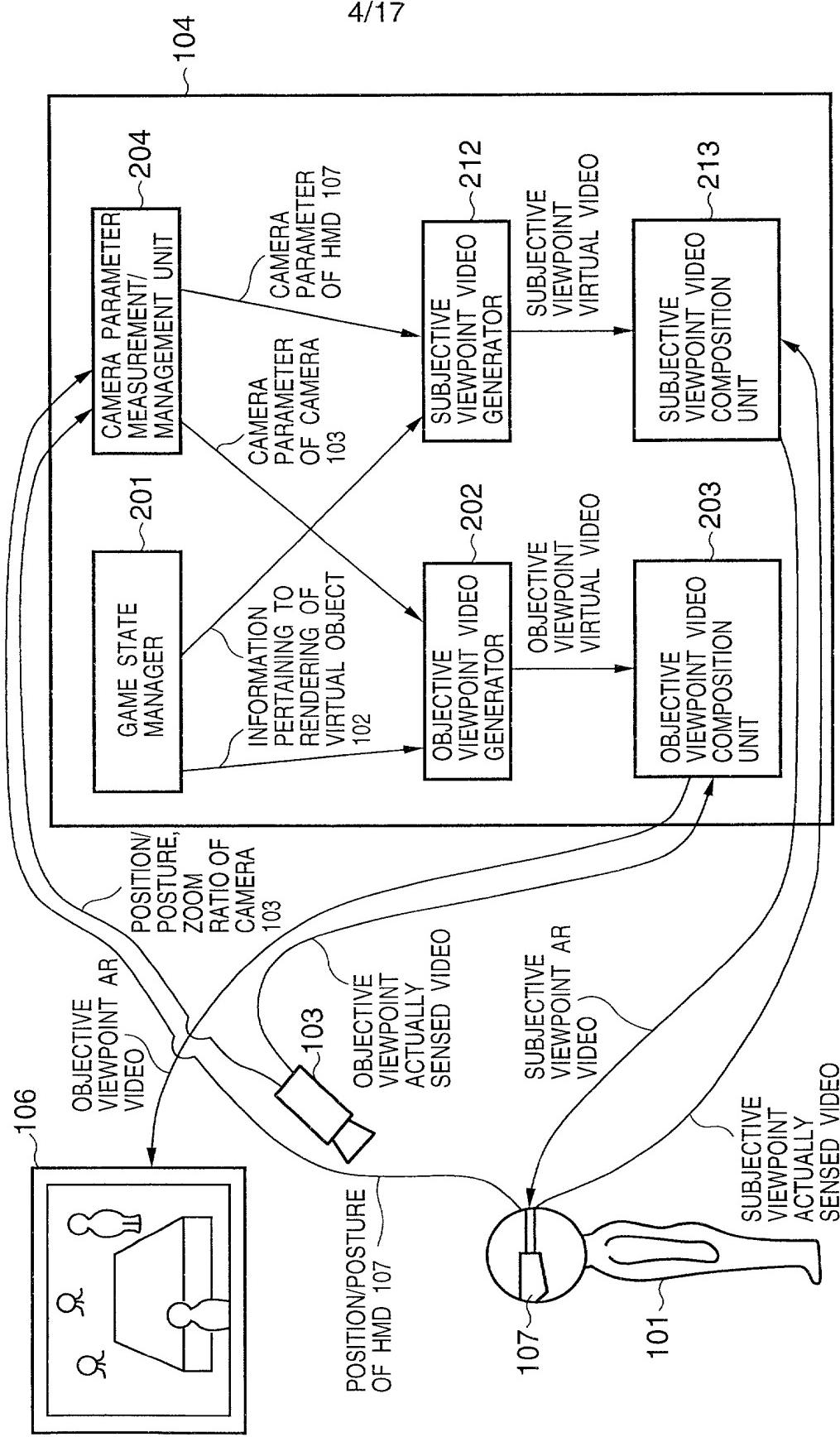
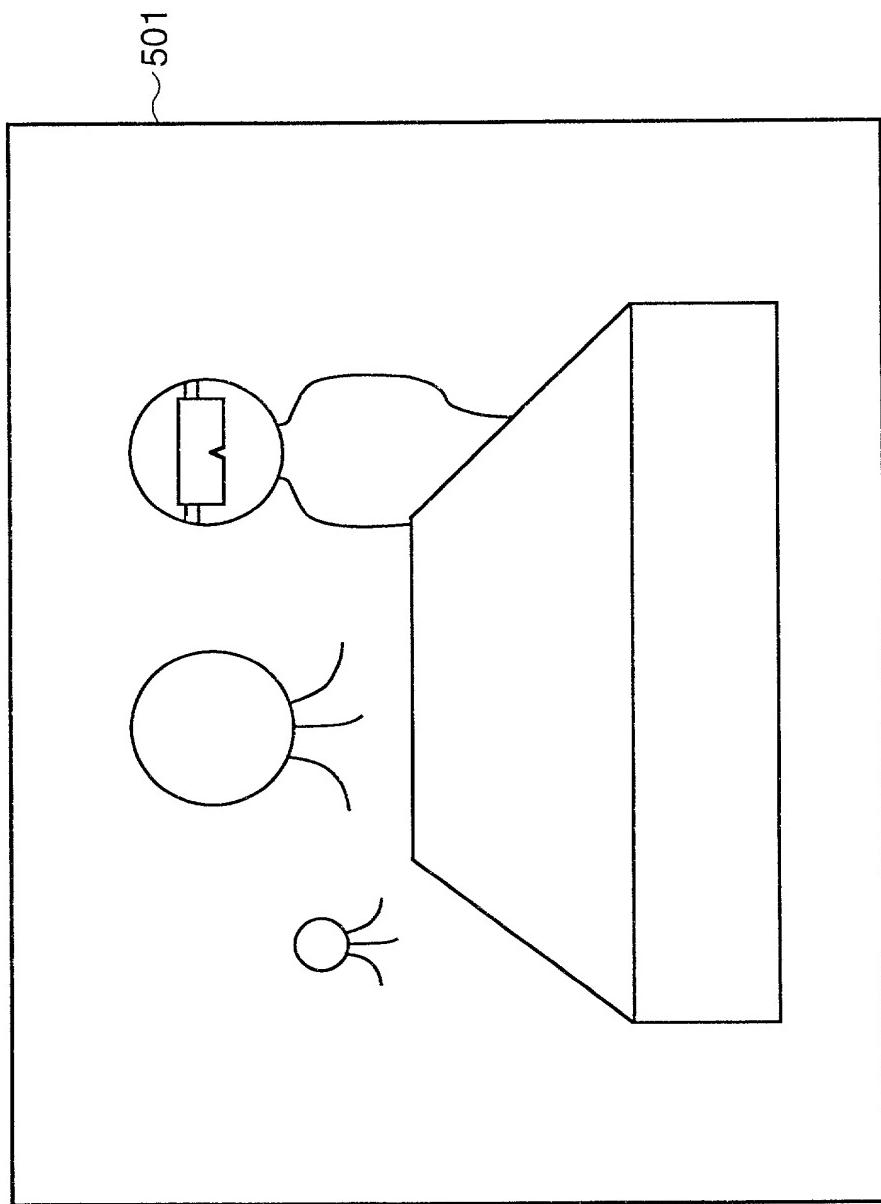


FIG. 5



**FIG. 6**

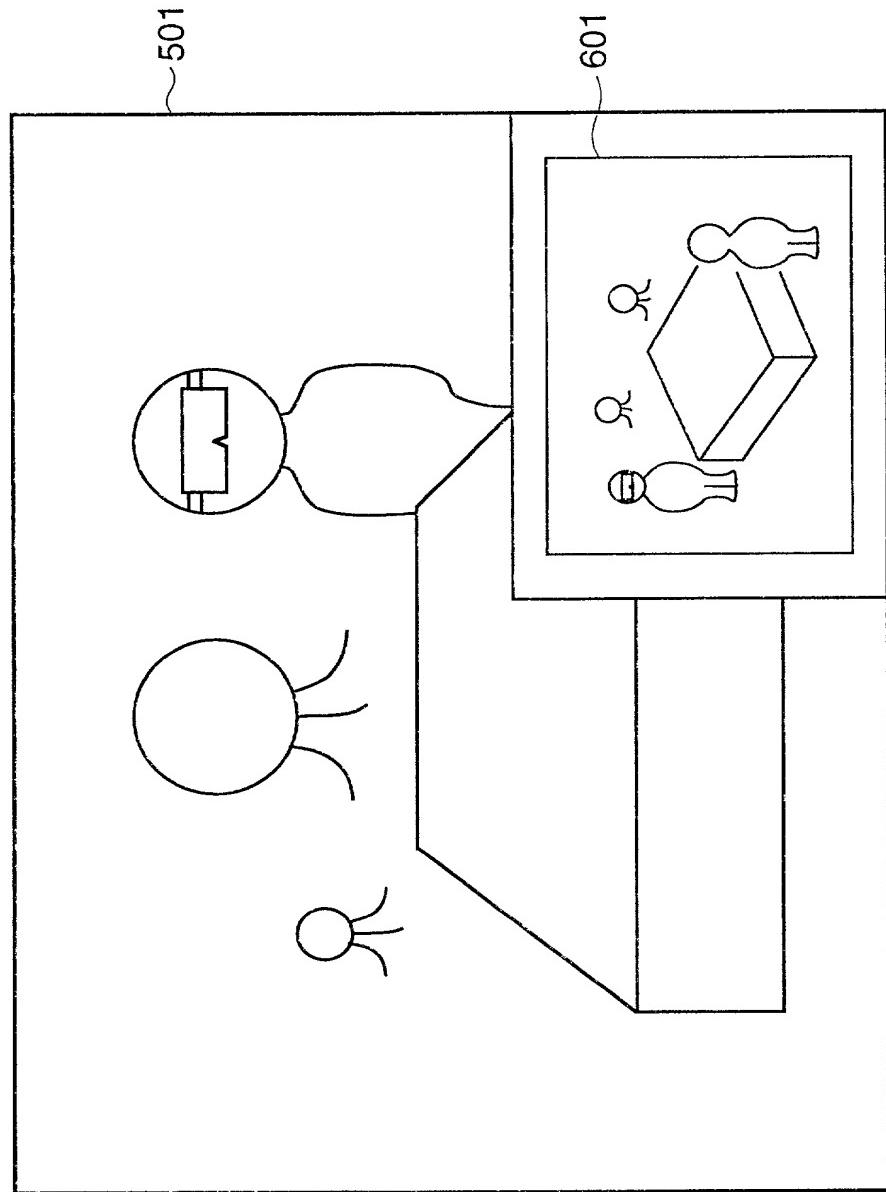
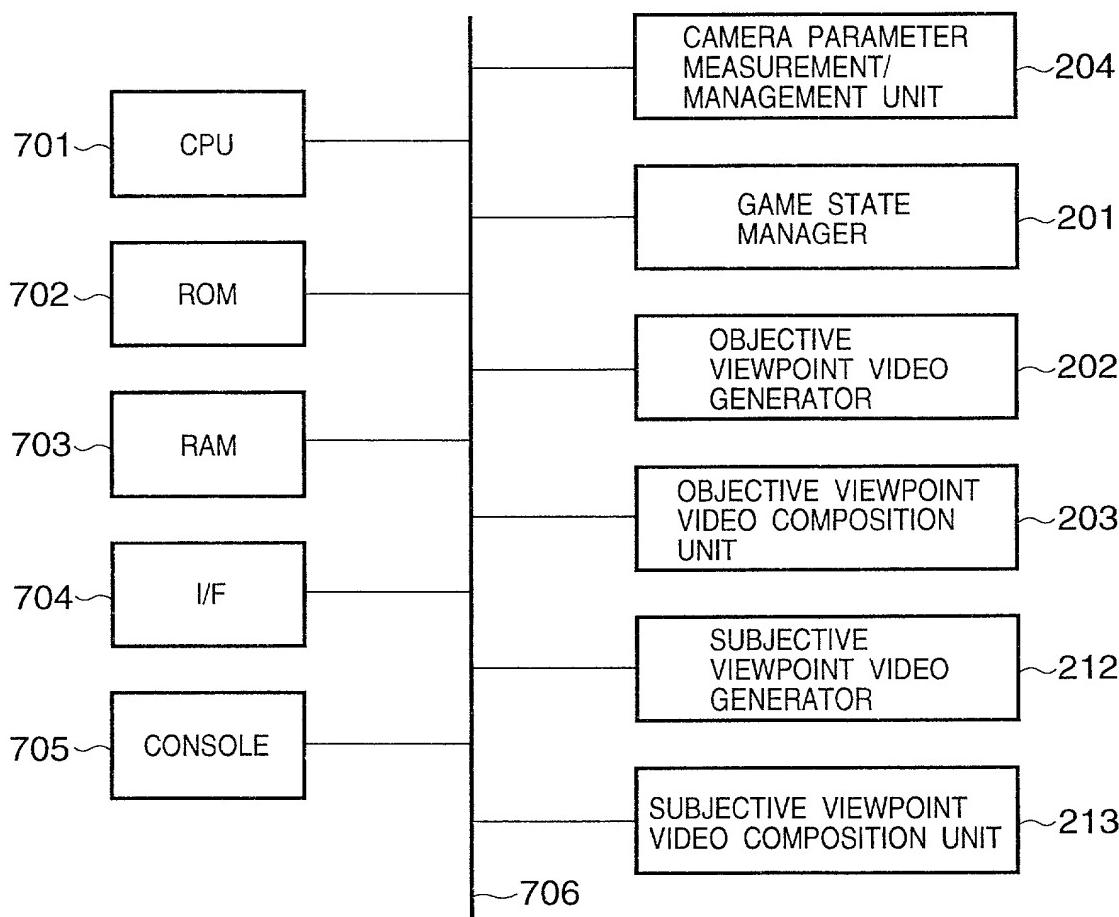


FIG. 7



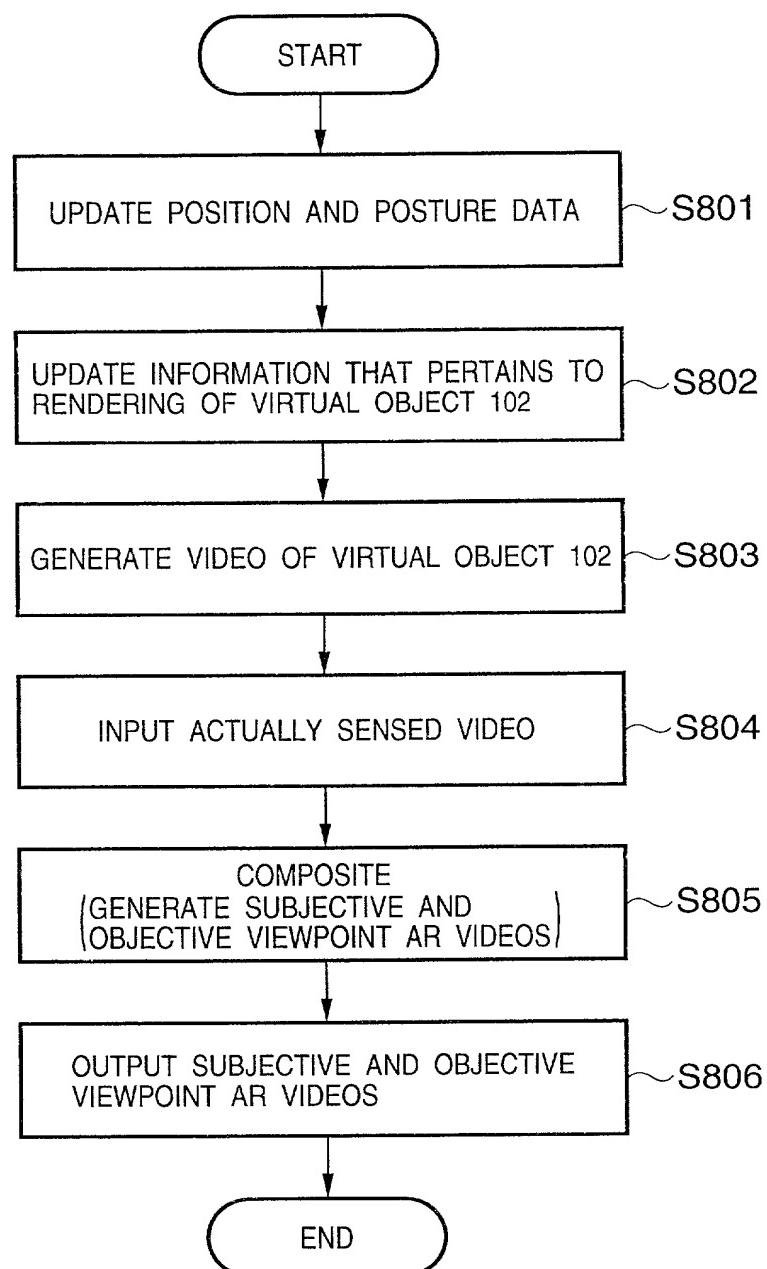
**F I G. 8**

FIG. 9

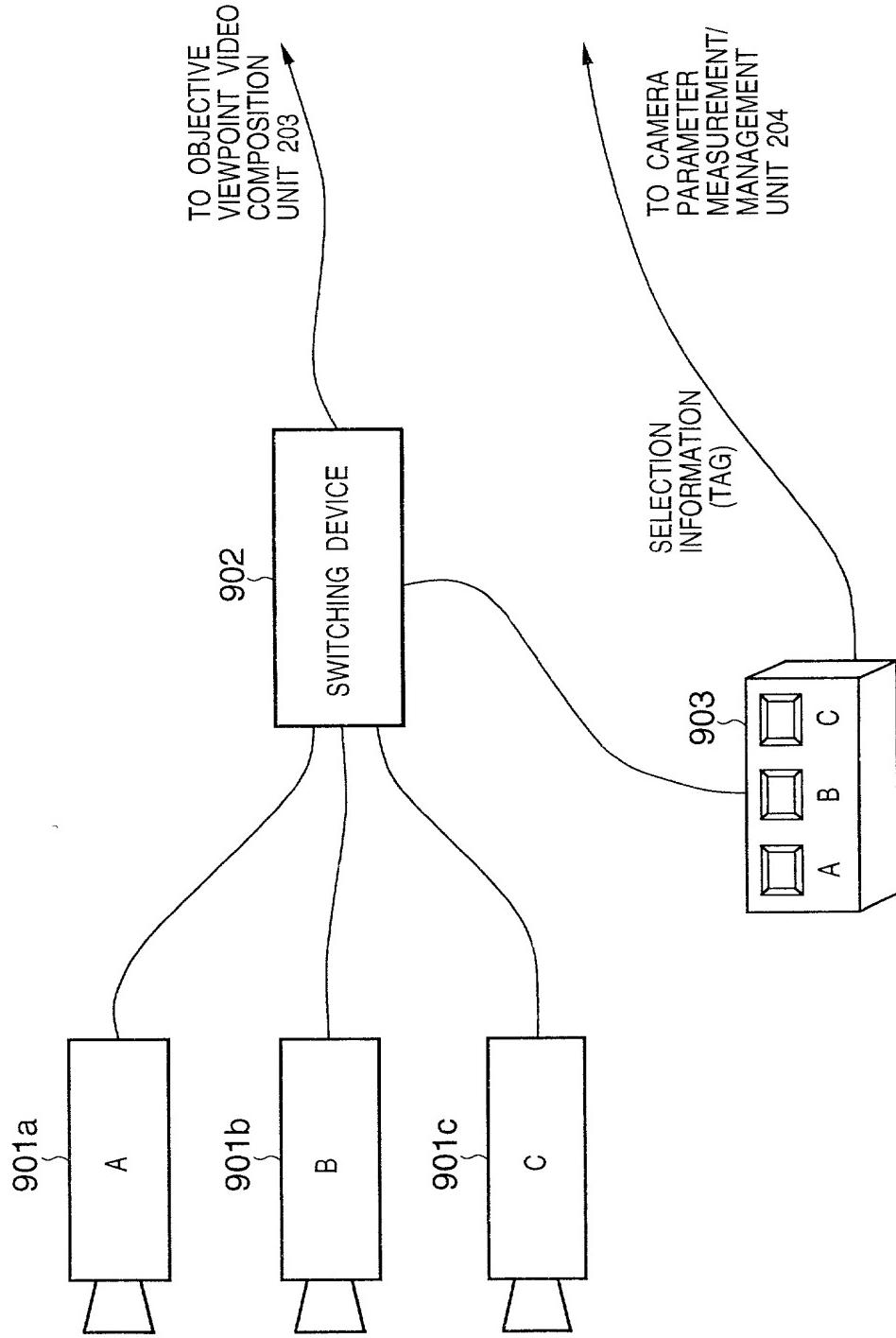
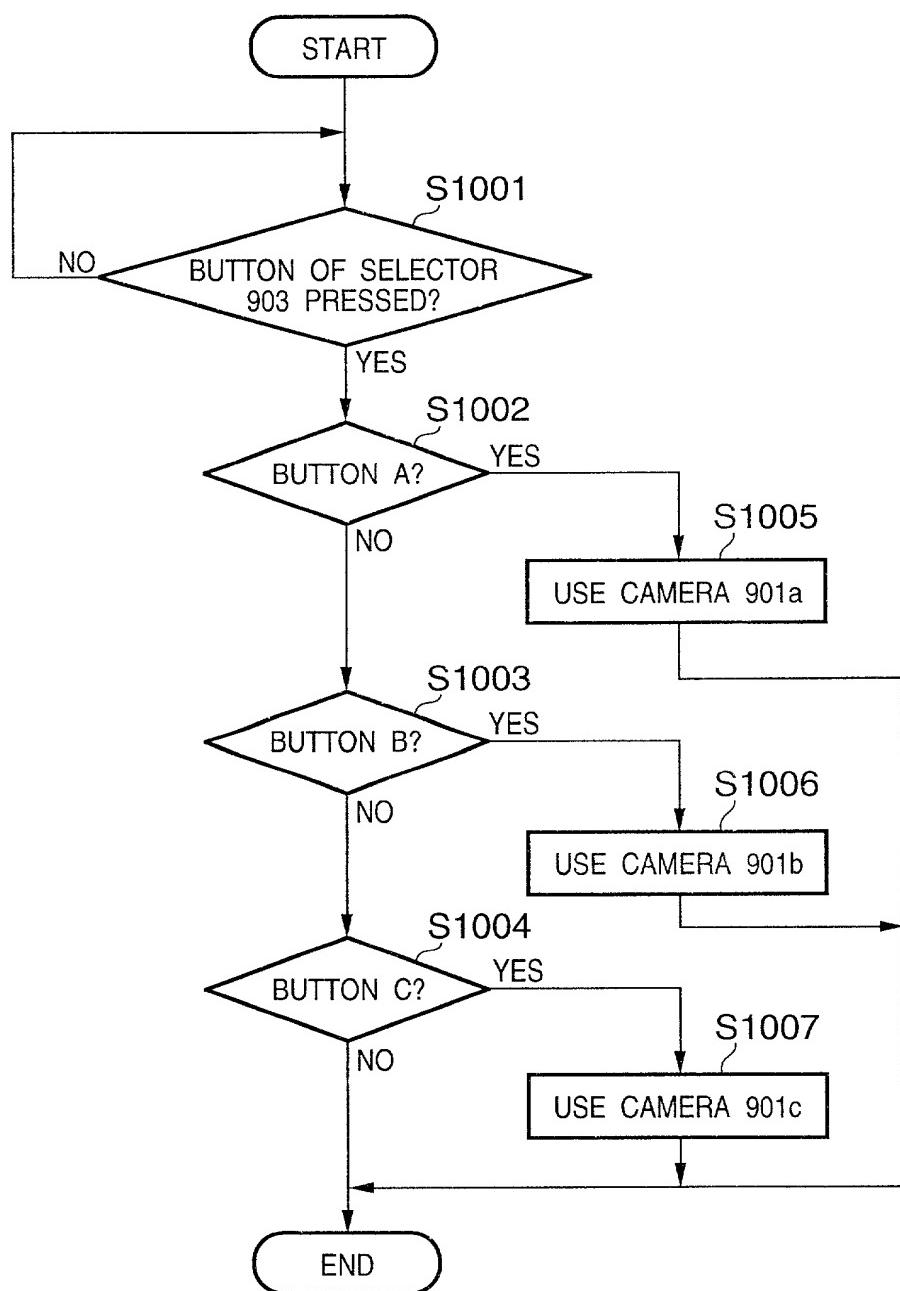
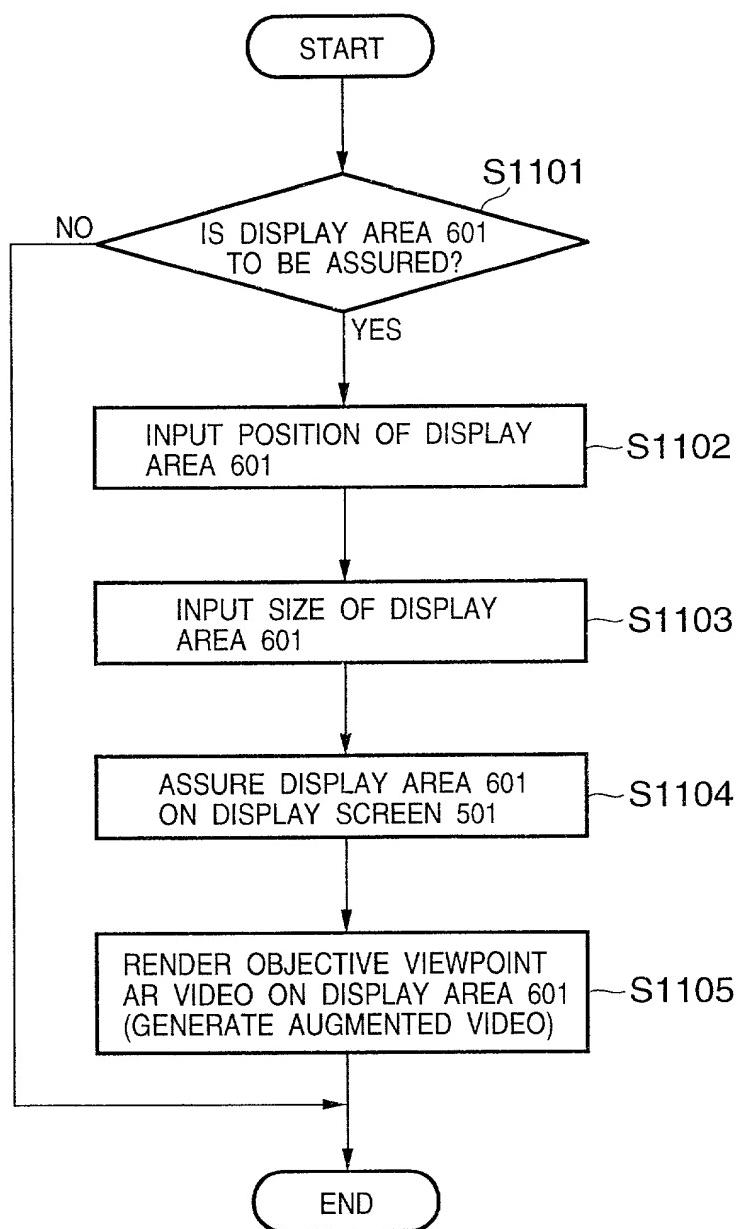


FIG. 10



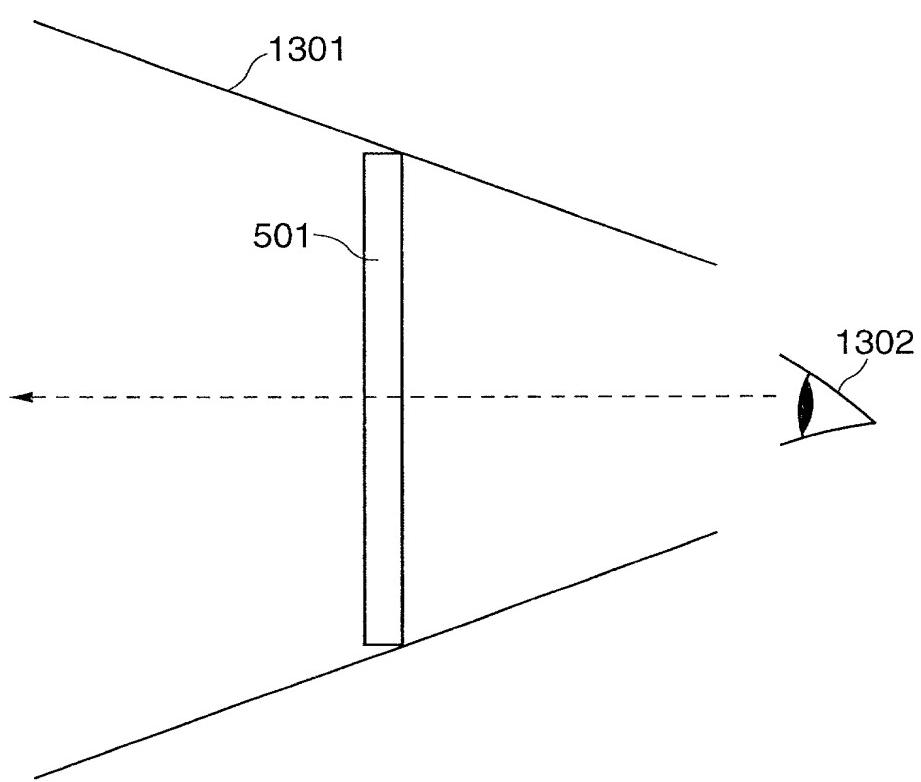
**F I G. 11**

12/17

## FIG. 12

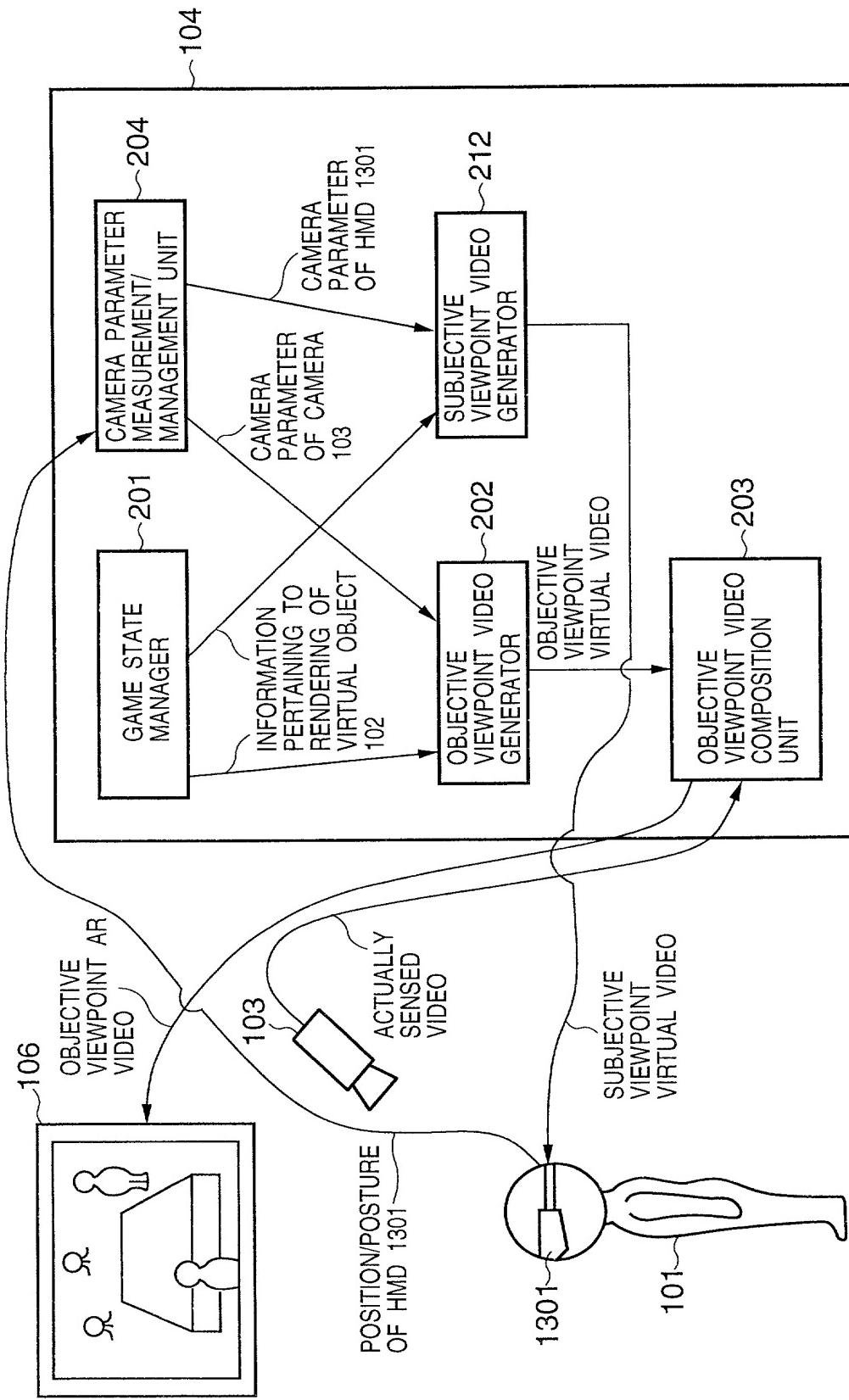
	1201	1202	1203
CAMERA	CAMERA 901a	CAMERA 901b	CAMERA 901c
POSITION	$(X_A, Y_A, Z_A)$	$(X_B, Y_B, Z_B)$	$(X_C, Y_C, Z_C)$
POSTURE	$(\alpha_A, \beta_A, \gamma_A)$	$(\alpha_B, \beta_B, \gamma_B)$	$(\alpha_C, \beta_C, \gamma_C)$
INTERNAL PARAMETER	$f_A$	$f_B$	$f_C$

## FIG. 13

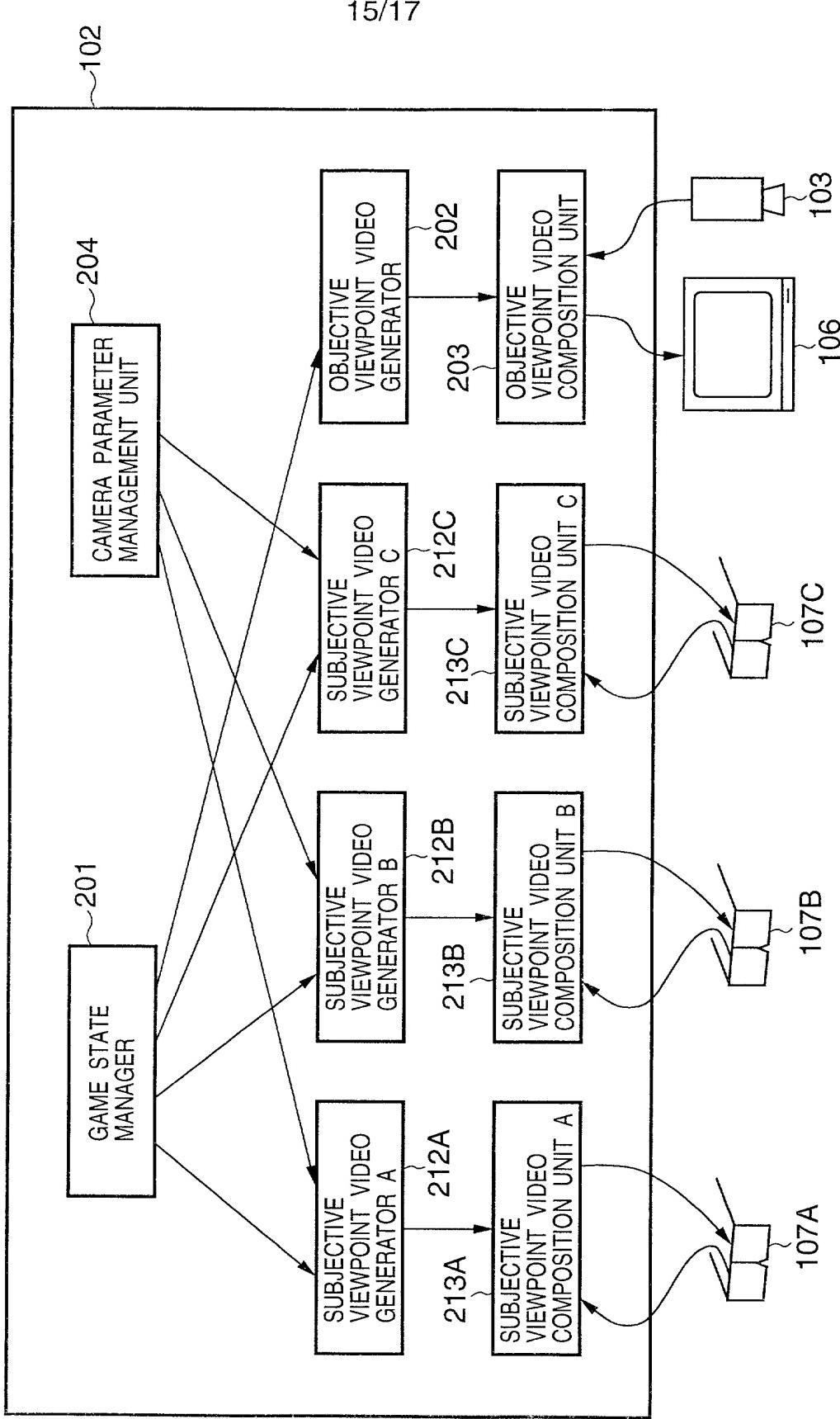


**FIG. 14**

14/17

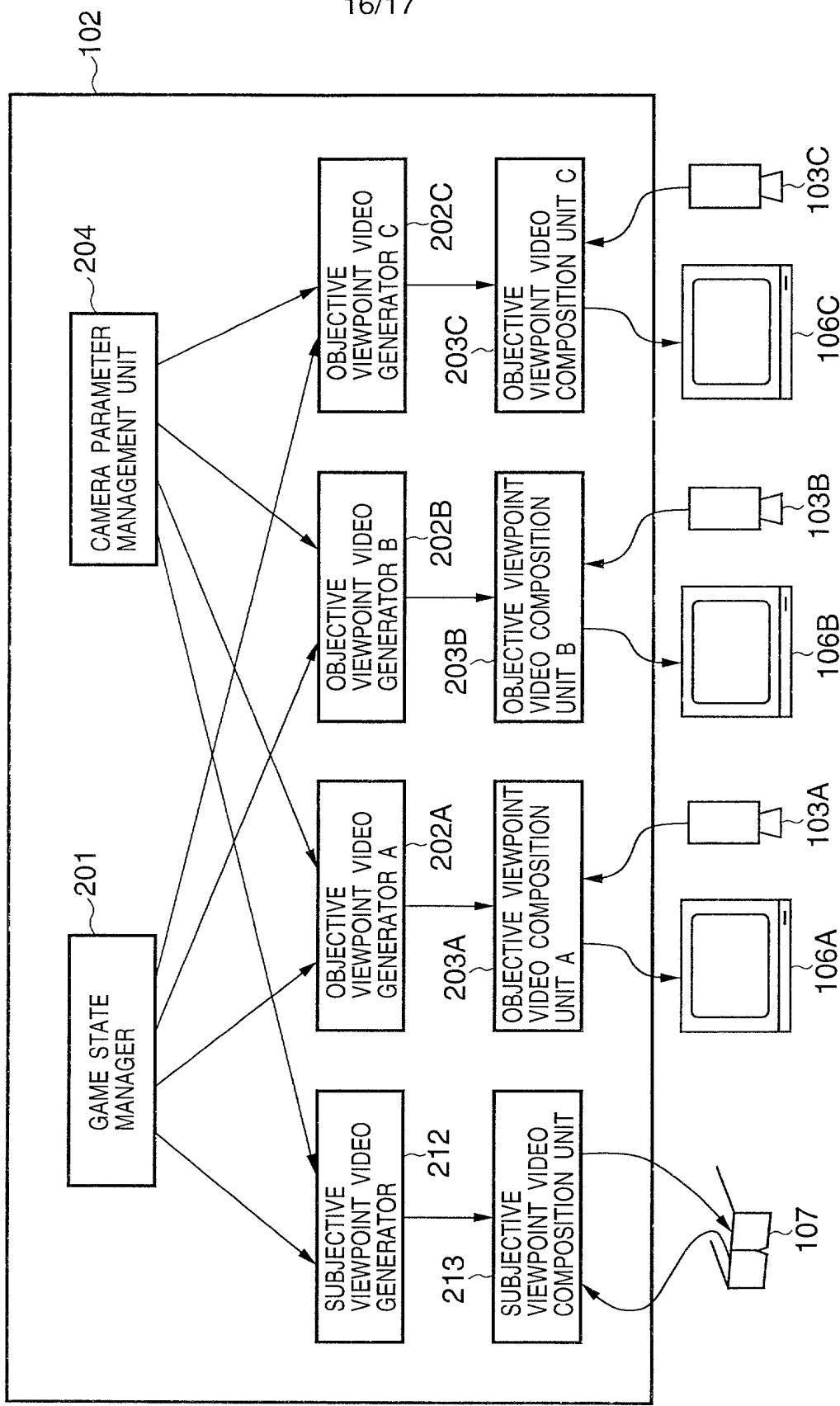


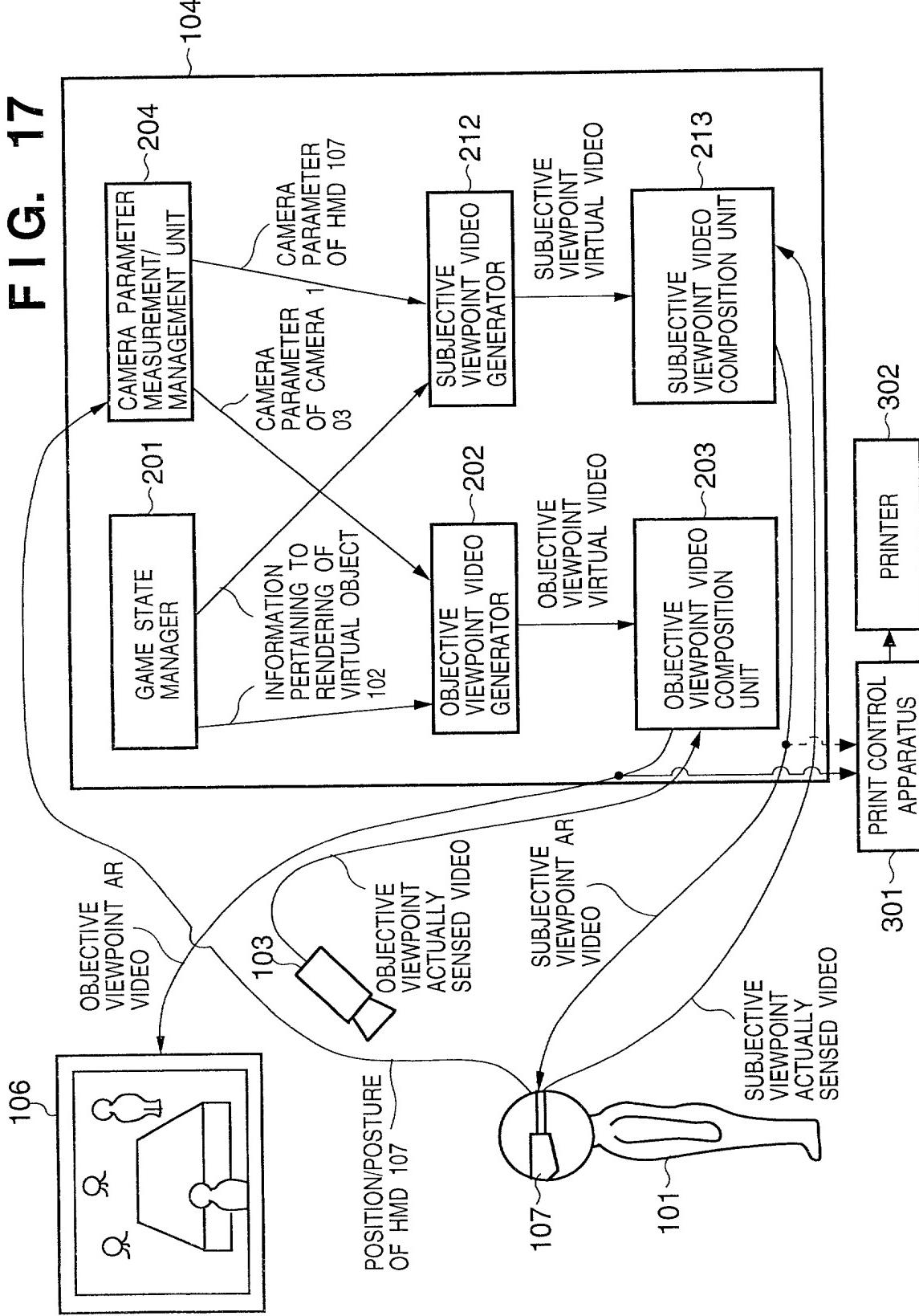
**FIG. 15**



**FIG. 16**

16/17



**FIG. 17**

**COMBINED DECLARATION AND POWER OF ATTORNEY  
FOR PATENT APPLICATION**  
(Page 1)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

**AUGMENTED REALITY PRESENTATION APPARATUS AND METHOD, AND  
STORAGE MEDIUM**

the specification of which [ x ] is attached hereto. [ ] was filed on \_\_\_\_\_

as United States Application No. or PCT International Application No. \_\_\_\_\_  
and was amended on \_\_\_\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR §1.56.

I hereby claim foreign priority benefits under 35 U.S.C. §119(a)-(d) or §365(b), of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT international application which designates at least one country other than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate, or PCT international application having a filing date before that of the application on which priority is claimed:

(Yes/No)

<u>Country</u>	<u>Application No.</u>	<u>Filed (Day/Mo./Yr.)</u>	<u>Priority Claimed</u>
JAPAN	2000-004716	13/01/2000	Yes

I hereby appoint the practitioners associated with the firm and customer number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and direct that all correspondence be addressed to the address associated with that Customer Number:

**FITZPATRICK, CELLA, HARPER & SCINTO  
Customer Number: 05514**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

**COMBINED DECLARATION AND POWER OF ATTORNEY  
FOR PATENT APPLICATION**  
(Page 2)

Full Name of Sole or First Inventor Kiyohide SATOH  
Inventor's signature Kiyohide Satoh  
Date 5, September, 2000 Citizen/Subject of Japan  
Residence 495-301, Kizuki, Nakahara-ku, Kawasaki-shi,  
Kanagawa-ken, Japan  
Post Office Address c/o MIXED REALITY SYSTEMS LABORATORY INC.,  
145, Hanasakicho 6-chome, Nishi-ku, Yokohama-shi,  
Kanagawa-ken, Japan

Full Name of Second Joint Inventor, if any Toshikazu OHSHIMA  
Inventor's signature Toshikazu Ohshima  
Date 5 Sep. 2000 Citizen/Subject of Japan  
Residence 30-21-607, Minamikase 4-chome, Saiwai-ku,  
Kawasaki-shi, Kanagawa-ken, Japan  
Post Office Address c/o MIXED REALITY SYSTEMS LABORATORY INC.,  
145, Hanasakicho 6-chome, Nishi-ku, Yokohama-shi,  
Kanagawa-ken, Japan

F511/A601948/ald